THE

ELECTRICAL REVIEW.

VOL. XXXVIII. FEBRUARY 28, 1896. No. 953.

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SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other Countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 3d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

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SUPERHEATING.

IN the discussion on Mr. Patchell's superheating paper, of those who spoke the majority did not know of what they were talking; so says the *Engineer*, which awards the palm, however, to Mr. Michael Longridge. This gentleman ought certainly to know of what he speaks when the subject is steam, for few have had better opportunities than he of acquiring sound practical knowledge. He contended that for superheating to be of use, steam should be at least 300° above saturation temperature, for unless this were so, there would still be liquefaction in the cylinder. Our contemporary draws the conclusion from Mr. Longridge's remarks that superheating cannot, in his opinion, bring about any improvement in the working of a good engine and boiler. The *Engineer* does not agree with him, nor do we think that he has given an opinion quite worthy of him. Granted that there would still be liquefaction in a cylinder using superheated steam, it is impossible to conceive that this would exist to the same degree as with wet, or merely saturated steam. To liquefy, superheated steam must first pass downwards through the saturated stage, and even though a degree of superheat may only represent a third or a fourth of a heat unit, still the heat is there, and must have gone into the cylinder metal and prevented some of the condensation that would occur to a greater extent had the superheat been absent. Even if we admit that superheat is of little value, *per se*, because of the small actual quantity of heat it represents, is it not a clear guarantee that at any rate no water is passing the stop valve as water, that evaporation has continued to the dry point in place of the steam being laden with water globules? Our contemporary wonders that condensation still takes place when superheat is used. If less superheat be used than will supply the heat converted into work during expansion, and the heat lost by the cylinder during this period and the exhaust period, there must still be condensation.

It almost seems to us that, in taking 300° as the minimum superheat, Mr. Longridge has made his calculation on the basis of the condensation shown by the saturated diagram, and neglected entirely the diagram which would follow if so great a superheat were employed. Obviously, if the loss of heat suffered by the cylinder metal be all made good by one cylinderful of superheated steam the cylinder would start, if not at saturation temperature, at least very much hotter upon its next stroke, and two or three strokes alone would find it superheated. There must be a degree of superheat very much less than apparently indicated by the saturation diagram, which will be sufficient to cause a very serious improvement. This is set down by one writer as the amount necessary to do a little more than make good the heat converted into work during the expansion stroke. In an ordinary instance, this might be a seventh of the latent heat of the initial steam as shown by the diagram, not the third

part or the fourth part, such as the saturation diagram would show. Of course, much depends on what is the true specific heat of steam gas. Is it ·480, as for saturated steam, or is it less? Say, ·23, as for air, suggests the *Engineer*.

Information is much needed on this point, but our contemporary asks, why speculate, for the moment, on figures, when practice does undoubtedly point to saving effected by superheating? This is a broad fact that will appeal to steam users, and the superheater in question, which has shown great saving of coal, will doubtless find a ready market, even though it may not be worked as a superheater. We do not, it is true, know how long it will last. Mr. Patchell has had a 12 months' trial of it, and the tubes appear sound and good. Mr. Raworth, who argues on the ground that 40 or 50 per cent. had been added to the boiler heating surface, and this had produced all the benefit, evidently did so without considering that this additional heating surface, if put into so much extra length of a Lancashire or a water-tube boiler, would have been practically valueless. It is the peculiar arrangement and treatment of the new heating surface that has produced the unlooked for results with the superheater, and drawn attention to an action that certainly needs to be investigated. Agreeing with much that our contemporary advances, we cannot accept its dictum regarding what it is pleased to look upon as the obscure action of water in a cylinder. What are the data? Metal surfaces exposed alternately to boiler pressure steam, and exhaust steam, with all that this implies in respect of the behaviour of the steam—a fluid, like its mother liquid—of critical temperatures. We should think that any other behaviour than the now commonly accepted one of water in a cylinder would be difficult to propound. Water has bad effects simply because it is so powerful a cooling agent, absorbing heat from the cylinder, not to raise its own temperature, but actually absorbing heat while falling in temperature, for it absorbs heat which becomes latent, and passes off to the condenser. We have heard and read arguments against the steam jacket, on the ground that as water was formed in the jacket, this might as well be abolished, and the water formed in the cylinder, and got rid of to the condenser, and, if water, once formed, would remain as water, and leave the cylinder as such, it would be comparatively harmless, and superheating might lose its value; jacketing would certainly do so. It appears to us that in asking Prof. Kennedy to explain how it is that he saved 11 per cent. with only 30° of superheat, and 22 per cent. with a superheat of 65°, our contemporary begs the whole question, and puts itself in the position of the doubters who demanded a sign. Apart from originally wet steam and radiation losses, the main cause of cylinder wetness is liquefaction by performance of work. Make this good, and there remains only the radiation and priming, and such loss as accrues by heating of the exhaust, a loss that becomes less as the exhaust becomes more dry.

Australian Landlines.

We have frequently had occasion to call attention to the unreliable state of the two main landlines in Australia, on which we at present depend for continuity in our communication with Australasia. These land lines, as our readers may know, are two in number. The two cables, which land at Port Darwin in the north of Australia, are served by the first of these—a landline which runs from Adelaide northward through the colony of South Australia. Owing, however, to the inconvenience caused by interruption of the two cables, which start from Banjoewangie in Java and are landed at Port Darwin, it was thought necessary to provide an alternative route, which was done by laying another cable from Banjoewangie to Roebuck Bay, in the north-west of Australia, to which point a landline running along the coasts of South Australia and Western Australia was extended. This second route has been unfavourably criticised by Mr. Playford, the present agent general for South Australia, who said: "Our line takes the whole of the messages; it is an easier line to work, running through the Continent from north to south, whereas the other line runs along the coast, and is more liable to be interrupted by thunderstorms and atmospheric causes." From this description, given by an unprejudiced official, it will be seen that the Western Australian landline cannot be looked on as an efficient alternative route. The list of recent interruptions to the above mentioned routes (which we publish elsewhere) gives an idea of the inconvenience suffered by the public, owing to the lack of a really efficient alternative route between Europe and Australasia, the need for which first directed attention to the Pacific cable project. We have before had occasion to point out, that although both South and Western Australia belong to the International Telegraph Union, according to Article LXXXII., Clause 4, in the rules of which these administrations should advise the official headquarters at Berne by telegraph "of all interruptions and restorations of communication affecting international traffic," still the list of interruptions which we publish to-day is not to be found in the official notices from Berne, and therefore may not be as complete as if it had been derived from the Bureau International, which should have been kept informed by South and Western Australia, according to the Convention to which both of these colonies are parties. Since writing the above we learn that the Eastern Extension Telegraph Company has received no telegrams from Western Australia since 18th inst., terrestrial communication being interrupted from both sides.

Researches at Low Temperatures.

It was not to be wondered at that Prof. Dewar would sit calmly down beneath the storm of criticism regarding the priority of his researches on low temperature. In a recent paper read before the Chemical Society, he reviews all the forms of apparatus which have been used since Pictet liquefied oxygen in 1878, and places the originality of his own modification in a strong light. He refers to the fantastic claim put forward by Prof. Olszewski, of Cracow, that because he used in 1890 a steel tube combined with a stopcock to draw off liquid oxygen, he had taught the world, to use his own language, "the method of getting large quantities of liquid gases." But when, in addition, Olszewski alleges, four years after the event, that the experiments made at the Royal Institution since 1891 are chiefly borrowed from Cracow, and that he is entitled to the credit of all low temperature research subsequent to 1891, because of his steel tube and stopcock invention, one can only wonder at the meagre additions to knowledge that in our time are unhesitatingly brought forward as original, and more especially that scientific men could be got to give them any currency in this country. Such persons should read the late Prof. Wrobleski's pamphlet entitled "Comment l'air a ete liquefie" (Paris, Libraire du Luxembourg, 1885), and make themselves generally acquainted with his work before coming to hasty conclusions on claims of priority brought forward by the Professor of Chemistry at Cracow. In the discussion which followed, Lord Playfair, Prof. Armstrong, and others paid well deserved homage to Prof. Dewar on account of his magnificent researches on the liquefaction of gases.

ELECTRIC LIGHTING AT BRIGHTON—THE "WRIGHT" SYSTEM.

By W. PERREN MAYCOCK, M.I.E.E.

London-super-Mare may fairly claim to be the most go-ahead town in the Kingdom as regards electric lighting. Though it was late in adopting the arc light on its fine sea front, the row of lamps which, since September 1893, has illuminated the section from the Brighton-Hove (or western) boundary to the Aquarium, will shortly be continued right away to the end of the Parade at Kemp Town, *i.e.*, beyond the further end of the electric railway, a total stretch of nearly 2½ miles. The posts for the new section are already *in situ*, and are of a still more handsome pattern than those along the King's Road. This lateness in taking up street lighting was owing to the engineer's desire to prove that a central station can be made to make both ends meet without the help of any public lighting.

But Brighton having once started does not confine its electric lighting to the sea front, and the main business thoroughfares—Queen's Road, West Street, Western Road, St. James's Street, North Street, East Street, Preston Street, London Road, and Castle Square, are already ablaze with arcs: and all the remaining principal thoroughfares and omnibus routes are being fitted with the same; while in the less important streets, wherever distributing mains are laid, the old gas lanterns are being utilised for incandescent lighting. When the work at present in hand is completed, the street lighting will comprise some 260 arc and 600 glow lamp standards. On the occasion of my last visit, I noticed men at work removing the old gas lamps in the main streets, a very gratifying sign of the times.

Extensive as is its street lighting, this is second in importance to the requirements of the private consumer, as proof of which it is claimed that Brighton numbers more customers per 1,000 of population than any other large town in Europe. For out of 25,000 buildings of all descriptions, 1,100, or between 4 and 5 per cent., are fitted with the electric light, and the number is rapidly increasing.

A few figures will prove of interest. At the present moment the light is used in some 500 shops, 210 private houses, 81 offices, 75 public houses, hotels, and clubs, 12 churches and chapels, besides 5 theatres, music halls, swimming baths, and the municipal offices, &c. Altogether there are 1,100 consumers on the books, as against 860 in 1895, 429 in 1894, 213 in 1893, and 91 in 1892.

Last month there were 23 new applications for current as compared with 13 in January, 1895, 11 in January, 1894, and 4 in January, 1893, showing that the rate of increase is in the ascendant.

In 1892 a profit of £12 was made, in 1893, £300, and in 1894, £5,000. In 1895, it being considered that the supply was for the public, not the public for the supply, the price per unit was considerably reduced, and although the exact figures are not yet out, it is probable that the profit for last year will exceed £1,000, whereas had the old charge been maintained the estimated profit would have been at least £6,000, so that the consumer may be said to have been benefited to the extent of some £5,000.

It will be remembered that the charge for current is made on the "Wright" system; and the average price per Board of Trade unit for the past year works out at under 4¾d., a figure which is actually less than the charge in any other town except Newcastle.

Let those electric lighting concerns whose districts abound not in "rich" residential quarters, take heart of grace, for it has been conclusively proved at Brighton that electricity is pre-eminently the poor man's light, and that poor districts pay just as well as rich ones (if not better), inasmuch as they are not given to switching on extra lights for a short time at that dread hour of 7 p.m., or thereabouts, when the "peak" of the load curve trends to such giddy heights. In other words, the artisan uses his lamps fairly continuously throughout the evening, and is consequently a better paying customer than the inhabitant of a mansion whose bedrooms are ablaze for, say, half-an-hour preparatory to dinner, and whose rooms are often unoccupied six months in the year; or the theatre manager who turns on hundreds of lamps for a few minutes for transformation scene effects. In the Brighton engineer's opinion, Trafalgar and Edwards Streets—the artisan shopping districts of Brighton—are more profitable than North Street or King's Road, and, on the Brighton or "Wright" system, obtain light at a much lower rate than those higher class thoroughfares, and actually at a less cost than gas.

To prove the good effect of the system of charging adopted, it is only necessary to mention the following facts: The mean day load in December 1895 was 40 per cent. higher than that in the corresponding month of 1894, whereas the maximum peak of the load curve in 1895 was only 26 per cent. higher than that of 1894. Again, in 1894 the sale of units per maximum kilowatt observed at the station has increased in these two years from 800 to 950, or another increase of load factor of 19 per cent., and this with practically the same amount of public lighting in both years.

Owing to the large number of private houses, churches, and chapels lighted, the Sunday sale is about one-half that of the average week-day sale.

The capacity of the present station is 2,000 I.H.P., but the very considerable extensions in the buildings in progress will enable a plant of about 8,000 I.H.P. to be installed, so that evidently the lamp connection curve must be pointing very nearly to the zenith. Of course it is only intended to put down the plant as it is required.

Through the courtesy of the chief electrical engineer to the Corporation, Mr. Arthur Wright, who conducted me over the new buildings, or at least so much of them as were in evidence, I was enabled to risk my neck on various ladders and springy planks suspended in mid air; but I came safely through the ordeal, with the principal conviction that the work of a central station engineer has a very considerable amount of responsibilty attached to it.

The spread of electric lighting in the low rental and (as I have shown) best paying quarters of the town, is without doubt due to the encouragement afforded by the "Wright" method of charging for current, according to which no reduction is given to any consumer until he has paid off his proportion of the heavy standing charges incurred in electricity supply, and these at Brighton, I was informed, amount to quite 85 per cent. of the total expenditure. To carry out this arrangement in the present state of the industry, it was found necessary at Brighton to charge 7d. per unit during the first 365 hours' use of the consumer's demand on the plant, per annum, and all electricity consumed after this is now charged at 3d., but Mr. Wright very soon hopes to be able to change this 3d. to 2d. The deviser of this system early recognised that the majority of electricity consumers are, like Mr. Mantalini, only concerned in the total amount of their bill, and it was necessary to devise a method of charging which would involve no extra clerical labour. This he has succeeded in doing by devising an instrument which shows at a glance how many units to charge at 7d. and how many at 3d. The fact that 16 other towns are adopting this system, shows that the old criticism of complication and incomprehensibility is not warranted.

An explanation of the Wright system is as follows:—Fixed in series with the consumer's meter is an instrument called a "demand indicator" or "rebate finder," the function of which is to register the maximum current taken at any time (exceeding 10 minutes) during any one month. It consists of a U-shaped thermometer tube partly filled with black sulphuric acid, and having a hermetically sealed bulb at each extremity. The left hand bulb has one or more turns of platinoid strip wound round it, through which passes the main current from the meter to the house. The air in the bulb tends to expand in proportion to the heat developed, and the liquid is forced down the left hand leg and up the right hand leg till it overflows into the right hand bulb. Let us suppose the first night of the month 6 amperes are used at one time; the liquid will overflow to that extent, and the overflow cannot run back: if for the next few nights the demand does not exceed 6 amperes, there will be no further overflow. Now suppose 10 amperes are used one evening, the liquid will rise in the right hand tube until the previous 6 ampere limit has been reached, and there will then be a further overflow corresponding with the additional 4 amperes. After this, there will be no overflow until such time as the current exceeds 10 amperes, and so on. At each monthly inspection, the maximum current demand is at once shown by the level of the liquid in the right-hand leg or "index tube," and the

average of these maxima for the three dark months of the half-year in question (October, November, December; or January, February, March) is taken to represent the consumers "demand" for that half-year. After each monthly reading is taken, the inspector, by tilting the inner hinged portion of the instrument, empties the liquid from the overflow bulb back into the "U"-tube, and the indicator is ready for its next month's work. This slow registering of the demand is a valuable feature of the instrument.

The consumer's "demand" being determined in the manner above described, if his daily average use at that rate is under one hour (N.B.—In some towns two hours is the limit fixed), he will be charged 7d. per unit; if over, all excess is charged at 3d. per unit, the account being sent in quarterly, but the reduction given in the second quarter in each half-year.

As an example. Supposing in the three dark months (January, February, March) of the present half-year, the monthly maximum currents are respectively 20, 17, and 14 amperes, the average will be 17 amperes. 17 amperes at 115 volts (the pressure at Brighton) = 1,955 watts. This being so, his daily average for the half-year must exceed 1,955 watt-hours, *i.e.*, he must consume 1,955 (watts) × 182·5 hours (*i.e.*, one hour per day per six months) = 356,787 watt-hours = 356·8 units, before the reduced price can be applied. Suppose his meter at the end of the half-year registers a consumption of 620 units, he will be charged 356 units at 7d., and 264 units at 3d.

The demand indicator has two scales, one of which shows the maximum current on which the "demand" is to be based, and the other the number of units to be charged at full price (these values being proportional to each other), the reading being taken from the level of the liquid in the right-hand leg of the U-tube, and both scales reading downwards. The instrument being glass-fronted, the consumer can satisfy himself that his account for current is correct.

Another important feature of the Brighton Electricity Supply is the use, in the residential districts, of what Mr. Wright calls the "combined system," whereby all the advantages of high and low tension distribution are secured. This is effected by using, in these districts, high tension alternating current at periods of heavy load, and low tension current at other times, but I must postpone the description of this interesting feature, which has worked so admirably in the past, to a future occasion.

A PROPOSAL FOR MINIMISING VAGABOND CURRENTS IN ELECTRIC TRAMWAYS.

Mr. Kapp, in a communication to the *Elektrotechnischer Verein* on December 17th last, recommends the system of insulated return feeders, with auxiliary E.M.F., to maintain the rails throughout their length approximately at the potential of the earth, as the best means of preventing vagabond earth currents, and the disturbances to which they give rise. Mr. Kapp proposes some improvements in the method of carrying out this well-known system, and gives an interesting calculation to estimate the additional outlay required for a line 7 kilometres in length, such as that running from the Brandenburger Thor to Westend, Berlin.

A three minute service in both directions is assumed. With a speed of 16 km. per hour, the average distance between the cars will be, in the case of a single line 800 m., and of a double line 400 m. Let the average consumption of current be 15 amperes per car. The current required per kilometre of a double line will, therefore, be $\frac{1,000}{400} \cdot 15 = 37{\cdot}5$ amperes, if we neglect, for the moment, the current required for starting. If the stopping places are 500 m. apart, there will be two starting cars per kilometre, which, however, will not usually start at the same time. Usually, an attempt will be made to arrange the working of the line so that the two cars will not start at the same time, in which case the greatest current required per kilometre of track will be 37·5 + 35 amperes, which allows for the starting of one car at a time. The fall of potential along an insulated track of l kilometres in length would, therefore, not exceed $72{\cdot}5\ l \times 0{\cdot}007 \frac{l}{2} = 0{\cdot}25\ l^2$ (assuming a rail resistance of ·007 ohm per kilometre for a single line), and would, on the average, amount to only $0{\cdot}13\ l^2$. Let us take the 7 km. line from the Brandenburger Thor to Westend, with the power station placed near the centre. If the rails were insulated there would be, according to the above formula, a maximum difference of potential of 3 volts, and a mean D.P. of 1·6 volts between the rails at the termini of the line and the rails near the power station. Since, however, the rails are not insulated the P.D. will be somewhat smaller. But we may always consider the maximum P.D. which would arise with insulated rails as one factor in the estimation of earth currents. Another factor is the length of the track, so that the total earth current will be proportional to the third power of l, where l denotes the greatest length of rails through which the current flows. In the example taken, $l = 3{\cdot}5$, and the number 10·7 therefore gives a measure of the total earth current.

Let us suppose that instead of a single power station at the centre of the track, we have two additional stations placed east and west of the original station, each being of sufficient capacity to work one-third of the track, *i.e.*, $\frac{7}{3} = 2{\cdot}33$ km. For each station l is then equal to $\frac{2{\cdot}33}{2} = 1{\cdot}17$, and the maximum P.D. between any two points of the track is 0·33 volt. The total earth current for each station is given by the number $0{\cdot}33 \times 1{\cdot}17 = 0{\cdot}385$, and for the three stations by the number 1·15. The earth currents are therefore reduced to $\frac{1}{3}$th of their former value, and the disturbed region confined to $\frac{1}{3}$rd. If we assume four stations instead of three, these numbers will be reduced to $\frac{1}{11}$th and $\frac{1}{4}$th. It is not necessary, of course, to erect so many separate power stations; the same object will be attained if we connect a single power station to the corresponding number of points of the track by return feeder cables, and take steps to keep the potential at the points of connection one-half the fall of potential in the rails below the earth potential. Moreover, a return feeder can be made to serve two points if the nearest point is connected to the cable through a resistance equal to the resistance of the cable between the two points. We would, therefore, by the application of two return feeders (one to the Brandenburger Thor and the other to Westend) be able to reduce the earth current to $\frac{1}{25}$th and the disturbed region right and left of the track to $\frac{1}{5}$th.

In each of these return feeders a generator is inserted whose field is excited by the current in the corresponding positive feeder. The object of this arrangement is to proportion the sucking effect of the generators upon the rails as nearly as possible to the current being discharged into the rails at each instant. In the case assumed above, both generators together must have an output of 9 kilowatts, and the cost of the whole arrangement, including the two return cables, would amount to about £1,500. The annual cost, including 10 per cent. depreciation, attendance and current at 1·2d. per kilowatt hour, would amount to £250.

Mr. Kapp's demonstration that earth currents are reduced in proportion to the third power of the number of points to which the return feeders are connected, shows that there is the possibility of reducing these currents to harmless proportions at moderate cost. His plan of adjusting the suction of the auxiliary dynamos to the load on rails by exciting the fields of the auxiliary generators by the positive current appears to be exceedingly simple and effective.

CENTRAL STATION WORKING.

The *Electrical World*, of New York, has from week to week since the beginning of the new year, published a series of articles on central station working. It is not a matter for surprise that the American engineers should be anxious to obtain information concerning what is going on in the various American stations, amounting in all to 2,244, when they are entirely without means to institute comparisons between the different results of working of electricity supply stations; and were there to exist a bureau of information such as our Board of Trade has practically become, in connection with electricity supply undertakings, they would be in a position to analyse and draw lessons from one another's work, even in the most minute particulars.

Mr. Cecil P. Poole is the first gentleman who contributes towards the series. He is in charge of a combined steam and water-power station, all the dynamos of which are driven from one common countershaft, this countershaft receiving its driving power from a turbine or steam engine as Mr. Poole finds most convenient. It is not long since it was pointed out in these columns that this system of depending upon a common countershaft, or one unit to supply all the energy had been tried in England and found wanting. We are therefore not surprised that Mr. Poole finds it necessary to shut down his station each day at noon for half-an-hour, and on Sundays from 8 a.m. to half-an-hour before dusk, for the purpose of allowing him to inspect and adjust his machinery. Mr. Poole no doubt has a great pull over some of the other American stations, in that during the hours that the load can be taken by the turbine, he puts his steam engine out of commission, and by regulating the flow of water by hand, can give a satisfactory supply to his customers during this period. He throws his engine in directly the turbine is fully loaded, his pulleys being so selected that the speed of the common driving shaft is a shade higher when driven by the water-wheel under a full load and with a maximum reliable head of water, than when driving by the engine; therefore, after the engine is thrown in, the water-wheel works under a constant load, all the fluctuations being above its maximum load. The fluctuations the engine governor takes care of, the water-gate of the tubine being left wide open, no regulation being necessary.

It was not long until the public recognised the advantages and convenience of employing motors for power purposes. It was then Mr. Poole's troubles began, and he found that his turbine, which he had so successfully regulated by hand before, required something in the nature of an automatic governor, and he proceeded to invent the necessary governor, with the result that he produced what he terms an absorption regulator, which apparatus operated on a dead resistance in such a manner that when the load suddenly varied, due to the throwing on and off of motors, this regulator had the effect of equalising the load on the turbine.

Unfortunately, Mr. Poole's governor does not seem to have met with any greater success than the ordinary governor for regulating the machinery operating electricity generators, for at this time a change was made which resulted in the removal of the whole of the steam plant to a new site, and the increasing of the water station on the old site.

Mr. Poole gives an instance of the practicability of electrically coupling two stations for the purpose of mutual assistance, and both instances admirably illustrate the simple manner in which this can be accomplished.

The fundamental principle in the combination of the water and steam power combined plant was to keep the water power plant constantly working at full load with an open gate, and by connecting the dynamos at both stations in multiple to the power circuit. This was accomplished to perfection, the water power driven dynamo driving the dynamo at the steam power station as a motor, and so relieving the steam plant of part or the whole of its load when the demand was very much below the demand of the motor power station, but the instant that the demand exceeded the capacity of the water power station the engine plant began to assist.

DIELECTRIC STRENGTH OF OILS UNDER ALTERNATING POTENTIALS.*

By PROF. ELIHU THOMSON.

In the course of tests made under the direction of the writer some two or three years ago, the interesting fact was noticed that the striking distances of high potentials in insulating oils were in some way variable with the frequency of the current or potential waves, or upon the time during which electric stresses existed in a given direction through the medium.

This relation has been confirmed by other and later experiments. The general effect was found to be that discharges at low frequencies are capable of puncturing mineral oil layers up to from one-third to one-half the thickness of an air layer required to just resist puncture by the same discharges, while, with high frequencies of equal striking distance in air, an oil layer of $\frac{1}{30}$th to $\frac{1}{60}$th of the thickness of the air layer was sufficient to prevent discharges. At frequencies such as 125 per second, a potential which would give one-half inch spark in air, may puncture from one-third to one-fourth inch of oil between the electrodes, while at frequencies of 50,000 to 100,000 a layer of oil of one-fourth inch may resist puncture when the spark in air is as much as 8 inches. The high frequencies experimented with were such as are given by condenser discharges over an air gap, including a primary of a few turns, with a secondary of a single layer of some hundreds of turns immersed in oil. The discharges, in such cases, are not continuous waves, but a rapid succession of oscillatory discharges with dead intervals or periods of inactivity intervening. The effect of carefully drying an oil was found to increase its insulating power. This was also true to a marked extent when careful filtering was resorted to, a decided decrease of striking distance through the oil with the lower frequencies being observed. It follows from this that oil used in insulating for high potentials with low frequencies should be kept clean and homogeneous, and free from floating particles.

Variations of temperature of oil did not, in the experiments made, greatly affect the striking distances for a given potential. The general fact, however, that with high frequencies the insulating power of oil layers is, as measured by the striking distance in air relatively to that in the oil, far in excess of such insulating power for low frequencies, seems to be unaffected by the dryness, clearness or temperature of the oil used.

It appears probable, also, that with partially conducting liquids like alcohol and water the behaviour with high frequencies is more like that of a true dielectric insulator than with low frequencies. As an interesting fact in this connection it may be noted that a high potential high frequency coil capable of yielding spark torrents over 30 inches of air gap between its terminals, still maintains its discharges even when shunted by a glass tube 1½ inches in diameter containing ordinary water, and long enough to bridge the gap.

It is difficult to account for the differences in the effects obtained with high frequencies from those with low frequency alternating waves. A time lag in the establishment of the full dielectric stress or full electrostatic field in the oil might account for the phenomena. According to this hypothesis if two electrodes under oil, separated a certain distance, instantly acquire a difference of potential this potential would not with equal rapidity strain the oil to the full extent. It might be assumed that the polarisation of the iron molecules requires time; or, it may be that only such part of the electrostatic field as is due to the ether is first established after electrification and that the increase of such field, due to the molecules of the substance, such as the interposed oil, is subsequent to the former.

If this were so the establishment of an electrostatic field at high rates in oils would present analogies with the case of magnetic fields in iron or metals.

It would also follow, if the supposition of a lag as above be true, that in condensers such as those using oil as a dielectric, the capacity would be less the higher the frequency. Again, if any such lag as is assumed exists, it would probably vary with different insulating media, and it may depend upon the molecular state, as viscosity, for example. Observations of the oil space between the immersed electrodes by polarised light could probably be used with certain media to detect any differences in time of establishment of electrostatic stress with different frequencies, it being well known that under high stresses certain insulating liquids become strongly affected in their optical properties, with rotation of polarised beams of light traversing them. If the optical effect noticed should be less in the case of high frequencies than with low rates it would indicate a probable lag of the kind assumed. Similar studies using solid dielectrics like glass, mica, &c., would also be desirable. Should the results be negative it would be necessary to attack the problem in some other way.

M. P. Jaret, about a year or more ago, in a communication

* New York *Electrical Engineer*.

to the Paris Academy of Sciences, gave the results of his investigation of the properties of mica. He found that it did possess, with rapid oscillations, what might be termed a dielectric hysteresis. Such a property may exist to a more marked degree in oils.

In the tests of the power of oil layers to withstand puncturing by high potentials a curious effect was noticed, which was that discharges under oil passed far more readily between balls than between sharp points. In other words, with any given difference of potential between the immersed electrodes, as measured by the air spark obtainable, pointed electrodes could be brought much nearer than balls without provoking puncture. With balls of one-half inch diameter as terminals and with low frequency (125), potential differences, ranging from 100,000 to 150,000 volts, the space between the points could be one-quarter that between the balls. The ratio between the length of spark in air and between sharp points in oil was 10 to 1 at 10,000 volts and 8 to 1 at 15,000, while with balls these ratios fell to 2·4 to 1 and 2 to 1, respectively. When flat plates were substituted for the balls the striking distance in oil was still further increased as compared with the distance with points. The seemingly anomalous action of points under oil, so different from their action in gases or air, is certainly curious, and the usual injunction to avoid points and edges as conducive to electric discharge does not seem to apply in such media as oil, at least when the potentials are alternating and at ordinary frequencies.

In experimenting with discharges in oil uniform results are only to be obtained by using carefully filtered oil, as ordinarily they contain suspended particles, fibres, &c., which appear to bridge the space between the electrodes and provoke a breakdown due to the non-homogeneous character of the dielectric. It is also necessary to discard oil after arcing has once occurred through it, as it will have become much weaker owing doubtless to the fine carbon particles set free and which remain floating ready to be drawn into the pace between the electrodes, thus giving rise to loss of homogeneity of the medium.

THE NEW YORK EDISON LIGHTING COMPANY.

In the *Electrical Engineer* of New York of recent issue, Mr. Jos. Wetzler gives a very comprehensive and well illustrated article dealing with the history and growth of the Edison Electric Illuminating Company, of New York. He traces the concern from the embryo state in which it existed in Old Pearl Street, and pursues its development from 15 years ago to the present date. During the first month of the company's operations, it was required to supply 85 houses, wired for 2,323 lamps of 16 candle-power. The capacity of the station consisted of six Edison-Jumbo machines, of 125 horse-power each, and the company confined itself to the supply of current to incandescent lamps only. Two years after the commencement of running, motor supply was begun, and it was not until a subsequent three years that any arc lighting was attempted. From this period onward the growth of the concern was very rapid, until at the end of 1895, the little station of 900 horse-power had developed into six stations, with an aggregate capacity of nearly 1,000,000 8-candle-power lamps, the lamps actually connected at that period being 271,123 16-candle-power incandescent lamps, 3,424 arc lamps, and 12,046 horse-power in motors, or altogether, an equivalent of 972,120 8-candle-power lamps. To supply these there arose the necessity of establishing six stations, and we think that had Mr. Edison been so far seeing, as Mr. Wetzler wishes us to believe, he would have recognised the importance of adopting a high tension current, either alternating or continuous, where the whole of the machinery could have been worked by one staff, rather than have made the same blunder as can be seen at home, where the growth of the business has necessitated the putting down of several stations to feed one network, and we think that the net income of the Edison Electric Illuminating Company, approximating to $800,000, might have been, we may say without speaking extravagantly, doubled, if Mr. Edison had adopted a system suitable to an extended district like New York.

It is instructive to us to know that when Mr. Edison found that his low tension system was incapable of satisfactorily supplying the district, he "invented the three-wire system." We have some recollection of this invention being ascribed to a gentleman on this side of the Atlantic, who we hold in as high esteem as perhaps Mr. Edison is held on his side. Referring to the words of the article, that his "three-wire system made low tension distribution practically commercial more than a mile away in the richest lighting territory," we have always understood that the concentration of the lights, the size of the mains, and the pressure, had something to do with this.

The favoured district that has been cultivated by the Edison Electric Illuminating Company is below the Central Park, and runs along the backbone of the island for a considerable distance, so that when the company could no longer extend beyond the commercial limit of even the "three-wire system," another station was erected or acquired, and so on *ad infinitum*, until we find that no less than six of these stations running in a line direct north and south.

A large amount of detail in connection with engineering data is given. Engines of 2,500 horse-power are used coupled to Edison-Jumbo dynamos, and we trust that they will escape a better fate than the unfortunate animal after which they are named, and will not be relegated to a museum of antiquities; but before these large units were ever dreamed of in America, Mr. Edison had the advantage, and no doubt pleasure, of visiting a well-known London station in which engines of nearly 2,000 horse-power were then running, and the pressure employed was calculated to be sufficient to supply any demand in London.

When we compare the advantages of generating electricity in large quantities, which, by the way, is the only means of making electricity supply a commercial success, we cannot but recognise the inestimable advantage both in the economy of production and in the capital outlay of having the whole of the generating station in one building and worked by one staff of engineers.

The switching arrangements which, to secure the successful working of a system, should be complete and thoroughly well made, seems in this case to be above the average in their comprehensiveness and compactness.

The method of administration, accounts, and system of records is set out at length, but the altogether different circumstances existing in America would render a detailed analysis of this uninteresting, although instructive, to our English readers.

The article furnishes us with a gratifying evidence of the progress made by the Edison Electric Illuminating Company in the district which, in such a short period, has developed from a supply of 2,323 16-candle-power lamps, to the enormous total of 972,120 lamps.

SOME BELGIAN ENGINE TESTS.

We have from time to time given space to discussion upon the relative economy of gas and steam engines, and, very naturally, steam engine makers have been inclined to express the opinion that we have viewed too favourably the claims of the gas engine. While for our own part we can scarcely see how it can be other than economical to obtain power from fuel in the most direct way possible, and for that reason we should welcome the direct production of electricity from burning coal in the same spirit as we now receive the gas engine as being a more direct application of heat than is the steam engine, we are none the less willing to afford space to a record of tests sent us by Mr. Bollinckx, of Brussels. Belgium conducts an honourable and fair rivalry with us in the world's market, nor does she seek those questionable political methods of stealing our trade, which have rendered it necessary for England to order "hands off" in respect of certain other people.

The tests which Mr. Bollinckx has sent to us have been made by the *Association pour la Surveillance des Chaudières à Vapeur*, and controlled by the engineers of the Cie du Nord, Messrs. Ranciat, Learrent & Aliamet, on two of the Bollinckx engines at the electric light central station of Erquelinnes. The cylinders were of 450 mm. diameter by 900 mm. stroke, and consumed 7·05 kilos of steam per I.H.P. hour inclusive

of jacket condensation. The subjoined table gives the principal results attained. They are signed by the director of the Association, M. Vinçotte.

	Engine A.	Engine B.
Boiler pressure	7·1 k cm²	7·1
Mean effective pressure in cylinder	2·2 „	2·52
Vacuum indicated	0·945	0·947
Maximum I.H.P.	116·5	134·8
Minimum „	104·1	117·7
Cut-off maximum	8·3%	9·9%
„ minimum	6·9%	7·7%
„ mean	7·8%	9·1%
Mean speed	80·53	79·90
Frictional I.H.P.	9·02	9·45
Steam consumption non-condensing	—	9·93 k.
Coal per I.H.P.	879 grammes	—
Percentage of ash	10%	
„ of moisture	5·65%	
Mechanical efficiency	92·85%	

The steam consumption when worked non-condensing was thus 40 per cent. in excess of the condensing rate. The saving by condensing is, therefore, about 28½ per cent.

The gross coal per I.H.P. works out at 1·93 lbs., and, deducting moisture and ash, at 1·62 lbs. of combustible.

For engines of 18 inches × 36 inches, which is very nearly the size in English measures, and a boiler pressure of practically 100 lbs. per square inch, the results are very good. We should have preferred it if Mr. Bollinckx had forwarded us a drawing of the engines showing details of the cylinders and jacketing, and particulars as to the extent to which the interior parts are polished. Without some such knowledge and some actual thermometric measurement of the steam, showing it to be dry or otherwise, the statement of bare facts of water consumption does not afford much ground for comment. We would also thank Mr. Bollinckx if he would cause to be forwarded to us the periodical reports of the Association pour la Surveillance des Chaudières à Vapeur. It is to be noted that the boilers employed in the test are stated to be tubular, and to have evaporated 7·7 lbs. of water per lb. of fuel, but had they been of Cornish type they would have evaporated 9 lbs., and the coal per H.P. would have been reduced accordingly. It is curious to see this foreign testimony to the superiority of the Cornish boiler when so much is being urged against the class in England.

ELECTRIC ELEVATORS, WITH DETAILED DESCRIPTION OF SPECIAL TYPES.*

By FRANK J. SPRAGUE.

(Continued from page 166.)

The next element is the water cylinder, which corresponds to the dynamo in the electric system, and on account of the high friction due to the packing, the efficiency of a water cylinder with its valves is not ordinarily equal to that of a dynamo, with which a motor stands to-day the typical example of an efficient energy converter.

The next element is the piping and the tanks, compression or roof, and, perhaps, an accumulator, into or through which the water is pumped for delivery to the controlling valves of the elevator, and that which corresponds to this in the electric system is its simple wiring, and if a storage battery is used, then this last in conjunction with it.

Any competent engineer knows that, measured by standard practice, a given number of pounds of energy can be delivered to the controlling apparatus of an electric elevator for less pounds of steam, that is, water evaporated, through the medium of no less than 50 combinations of engines and dynamos, than can be delivered to the valves of any hydraulic cylinder through the standard pumps permissible in average elevator service. To be specific, the average water evaporation on a compound duplex pump, which is almost universally used, will in practice be not less than about 60 to 70 lbs. per horse-power of water energy delivered to the controlling valves, whereas the electric combination will easily give the same for less than 40 lbs.

* Paper read at the American Institute of Electrical Engineers, New York and Chicago, January 22nd and 29th, 1896.

There are exceptional conditions in which a higher economy can be gotten in a hydraulic system, but they are few and are not typical, and under equal conditions the steam consumption in an electric system can be cut in two.

But this is not all. The fact is persistently ignored, although the attempt is made to offset it by recent experiments with a differential piston, that a standard hydraulic elevator uses the same amount of water under the same pressure for every foot of travel of a car, which volume of water and pressure are determined by the maximum load which has to be carried, although the average load on the ropes, including the excess of car over counter-weight, is not over one-third of the maximum. On the other hand, the electric elevator uses, and must use, under normal conditions, current directly proportional to the work, modified in a small degree by starting and slow running.

In short, over and above the friction load of the generating system, the steam consumption in the engines and the generation of electricity in the dynamo vary with the demand of the elevator machines. It is a system which is of necessity automatic.

On the other hand, the hydraulic system is one of the most flagrant violators of the relation which should exist between demand and supply. It is a system of transmission by water, having at one end a generating plant doing full duty for every foot of travel of its piston, with a variable duty on an elevator car at the other end, and an intermediate straight line water engine with its pipes and tanks taking care of that variable duty and using the balance of its energy in heating the water which passes through its valves.

Lack of economy, however, is not the only objection to the hydraulic system when looked at from the architect's or builder's standpoint. Until recent developments, these have always been strictly handicapped, not so much perhaps in the matter of cost, but in the internal arrangements of the building as well as in the lay-out of the basement, neither of which could be finally and satisfactorily, if even then, determined, until the particular type of machine had been accepted by the owner, and the contract finally made for it.

Nor has there been either singleness of design or unity of plan of operation. Each maker has had his own form of construction, his special method of control. Every building has brought up a problem more or less new, or at least conditions which had to be seriously considered in determining the elevator service. Horizontal and vertical machines, in basement or shaft; high or low multiplications; long and short, single and jointed cylinders; big and little diameters; large and small sheaves; free and suspended counter-weights; pulling and pushing machines; direct and differential pistons; roof tanks, stand pipes, accumulators and compression tanks; high and low pressures; hand rope, wheel or pilot-valve control; simple or compound pumps—all have made a nightmare of complications, giving more initial and continuing source of complaint and dispute than all the other engineering problems in a building.

So what more natural than that they should turn to electricity for emancipation? And this tendency is augmented by other reasons.

Leaving out central station supply, always, when properly equipped, to be preferred when the electric service is of a spasmodic or limited character, and considering for the present those large plants which characterise the modern office or hotel building, and in a way rival central stations. every engineer knows that the fewer the number of well proportioned units, the more alike they are, the freer the interchangeability between themselves, and the greater the extent to which any one unit can be utilised, the better the system for power generation and conversion, no matter what its character.

The best modern practice makes a three-unit direct-connected engine and dynamo plant the best for lighting a building. There is an empirical relation existing between the number of lights required in a building as ordinarily designed, and the elevator service. When, in addition to the lighting service, such a building adopts electric elevators, it is not now necessary that it shall add an independent generating plant.

All that is required is that the three units should be somewhat increased in size, and perhaps one of them preferably divided, the mains all taken to a common switchboard with two-way switches, and every engine and dynamo thus

made interchangeable on either the lighting or elevator circuits, and at times both, especially if using a slow acting corrective converter, some of each can be run from the same engine and dynamo. So, instead of five or six units, some water and some electric, the entire generating plant is reduced to a single system consisting of three units of one size, or two of that size and two of a half size, which can be run interchangeably, and one of which is almost always in reserve.

Just here it is well to consider the probable application of the storage battery which, if built with plenty of lead, with large surfaces and for heavy momentary discharges rather than for long time steady discharges, will prove a most important adjunct to elevator service, which, like railway work, is spasmodic in character.

A modern office electric elevator on actual average service requires an expenditure of about 1 kilowatt-hour per car mile of travel for every 8 or 10 feet of platform area. A car will make from 1½ to 2½ miles per hour, so that a battery of six elevators will run from 9 to 15 miles, although very rarely making over 12 miles per hour. With an ordinary car, say from 30 feet to 35 feet area, this would mean from 3 to 3½ kilowatt-hours per car mile of travel, or say 35 to 40 kilowatt-hours for a battery of six machines. Without a battery this would require a 120-kilowatt machine as ordinarily rated, worked at an average of 35 to 40 per cent. load. With a properly constructed battery a 60, or even a 50-kilowatt machine will handle the elevators.

Roughly speaking, a storage battery should be able to stand twice the dynamo rate for from three, to seven or eight seconds, and the dynamo rate for one-half a minute. If it has an hour discharge capacity equal to the dynamo capacity in kilowatt-hours, it should be perfectly capable to run the Saturday, Sunday and night service required in an elevator plant without losing more than one-half its charge.

So much for the general conclusions on electric elevators, which are necessarily more or less brief.

To meet the hydraulic machine there was designed and developed what is now known as the Sprague-Pratt multiple sheave electric screw elevator following the general lines of a tension hydraulic machine in the matter of rope movement, limit safeties and method of control.

The net result has been, that this machine now stands the superior to the hydraulic elevator, in that it has its speed and capacity with, if anything, greater safety, and certain advantages in its automatics.

On high lifts it occupies less space; it is more flexible in its application, is more economical to operate, and it is more easily cared for.

General Description.—The machine may be described as the combination of two old elements with one new one, with specific safeties and methods of control.

Briefly, it is of the horizontal multiple sheave type, with a travelling crosshead and frictionless nut driven by a screw revolved by a motor directly connected, and governed by a pilot motor and rheostat.

The general construction consists of a heavy main beam, carrying the travelling crosshead and the lower screw bearing, with special castings bolted at each end, one carrying the fixed set of sheaves, and the other the thrust bearing, brake and motor. The regulating apparatus is independent and self-contained, and is placed on the wall. From the car to the system of multiplying sheaves the direct multiplying machine and the horizontal hydraulic elevator are practically the same. The crosshead, however, marks the point of departure in the two types.

In the hydraulic machine, this crosshead is rigidly attached to the end of a rod, which terminates in a piston moving in a cylinder, having an inside length equal to the lineal movement of the crosshead. This cylinder, in the vertical type of hydraulics, varies from 30 to 50 feet in length, with from two to 12 sheave multiplications, and in the horizontal types the multiplication runs as high as 14, with corresponding diminution of length of cylinder and increase in cross section. Whatever the gearing, however, the length of cylinder is a function of the car travel. In this electric elevator, the crosshead being moved along a screw, stationary, so far as the lineal movement is concerned, there is, with any given number of sheaves—only one variable—the length of screw; and, for all heights above, about 100 feet, the electric machine has an advantage in matter of length, which, with increased rises, becomes of great importance.

Looking to the needs of office buildings, there has been adopted two methods of rope multiplication, determined by the height of building, and so selected that the length of machine over all shall not exceed about 30 feet for rises approaching 300 feet actual car travel. From this the length grades down to about 21 feet, so that all rises between 60 and 300 feet can be taken care of with an extreme variation of 9 or 10 feet in the length of machine, and there is thus provided limiting dimension data of great convenience and utility.

These systems of multiplication I may term direct and indirect. In the former, the entire multiplication, varying from 6 to 10, is done at the machine, and the ropes lead from the end sheaves over the shaft sheaves direct to the car. A free counter-weight is used, the ropes being fastened to the car frame. In this method, which is that common to all horizontal and to many vertical hydraulic machines, the hoisting and counter-weight ropes have unequal duty; furthermore, the ropes having the maximum bending, travel on the outboard sheaves at the same speed as the car. This last is the case also with all vertical hydraulics. In some of the latter, the counter-weight is carried in the cylinder on the piston, or in the strap, or both, its weight being as many times that of a free counter-weight as there are multiplications. Sometimes both methods are used.

Economy of operation and smoothness of movement, however, are antagonistic in their relations to the amount of counter-weight carried. The best method is probably that used when there is a single multiplication in the shaft, giving a two to one counter-weight travelling at half speed, and carried by all the car-hoisting ropes, as is done for short rise vertical hydraulic elevators.

For long rises I have adopted a combination vertical and horizontal machine rope practice, giving even a more compact machine, a longer life of ropes, and better counter-weight results.

In this indirect system there is a division of multiplication, which, while having the same effect so far as speed of car and length of machine are concerned as a high direct multiplication, has an entirely different result in the wear on the ropes and the amount of counter-weight which can be carried without jumping.

This is accomplished by making one-half the multiplication (6 or 8) on the machine, the ropes, properly proportioned, going thence to the bottom of the counter-weight frame, which has a single multiplying sheave on top. The car ropes go over the shaft sheaves, under the counter-weight multiplier, and back up the hoistway, where they are anchored, giving a car speed twice that of the counter-weight. The equalising chains, used to make the pull of the car with any given load constant at all points of the hoistway, are fastened to the bottom of the counter-weight frame and anchored in the hoistway.

The space occupied by this multiplier is only 2 or 3 inches more than by ordinary form of counter-weight. A proportionally shorter screw, fewer revolutions, and sheaves of greater diameter, characterise this type of multiplying machine.

This system seems to be the best yet devised for long rises, for not only do all the car ropes do equal duty, both with relation to the hoisting strain and the counter-weight, but the rope wear must be less, because of the division of speed and multiplication, the necessity of changing only one-half of the ropes at a time, and the possibility or reversal of the ropes on the multiplying machine to get a new wear.

Where space is limited, I use a double decked machine, and in the new commercial cable building, which is to be 21 stories high, the machines will be treble decked, and about 10½ feet in height.

Details.—Turning now to the detail construction and operation of this machine, there are a number of features claiming special attention, each unique in character, and marking a radical departure from all other elevator practice. These are the nut, screw and thrust bearing, the brake, the motor, and the regulator apparatus.

One of the most interesting, as well as important features, and, perhaps, the one which has been most frequently attacked, is the nut system. It joins the crosshead of the travelling sheaves by a conical seat. There is no fastening

between the nut and the crosshead, the continual weight of the car always keeping them in contact, and the friction at this point being greater than between the nut and the screw, enables the latter to transmit a straight line movement to the crosshead when the screw is revolved by the motor, and also to revolve the screw and drive the motor as a dynamo, when the mechanical brake releases the screw to allow the car to descend. These are the normal functions af hoisting and lowering. There are several other distinct functions of this nut, which will be described in considering the "safeties."

Continuing the line of transmission of power, the only points of contact between the interlocking nut and screw are by a chain of balls, which occupy a number of threads, and enter and leave the ends of the nut through tubes which are connected together so as to make a continuous conduit. This is one of the most vital points of the elevator apparatus, and herein lies one of the most potent reasons of its success, the reduction of friction by rolling instead of sliding surfaces on almost all parts under pressure; for not only is the nut so constituted, being in fact a developed spiral thrust bearing, but the thrust bearing at the motor end of the screw is taken on balls, and the sheaves are carried on ball or roller bearings.

This nut being a vital part, its development has been most thorough, and a peculiar treatment of steel which has been adopted renders its surface so hard, that the wear is very small, and it is well within commercial limits.

So free is the machine from static friction, that it is possible to start the car with a very slight increase of current over the normal hoisting current, providing time be taken so that the work done in acceleration is small to the work of lifting, although that is not the usual practice.

The balls have an average crushing strain of 25,000 lbs. each, but the working pressure varies from only 50 to 125 lbs. per ball.

The nut system is a compound one, for, besides the working ball nut, there is another, called the "safety nut," to which I will make reference later, keyed to it, and between the two is a powerful spring under compression.

The screw is a forged bar of high carbon steel, with a peculiarly shaped thread, the finished screw having a tensile strength of 700,000 lbs. It passes through the clearance hole in the steel trunnion crosshead, which carries the travelling sheaves, then through the nut, and is carried at the outer end by a fixed bearing.

This screw is sectioned, being joined to the armature shaft by a cone-seated coupling, secured by a taper gib.

The in-board end of the armature shaft, which is, in effect, the extension of the screw, terminates in the thrust bearing, where the pressure is taken by about 200 steel balls carried in a bronze guide plate and bearing, by specially hardened steel discs. The thrust of the screw being thus taken up on the in-board end, the strain on the screw is invariably between that end and the travelling crosshead—never beyond this; hence it is always under extension strain—never under compression, and cannot buckle.

The action of the balls on the screw, which is untreated, is peculiar. They form a path for themselves, partly by wear, but principally by rolling compression of the steel, which finally becomes exceedingly hard, such that the edge of any ordinary machine tool would be turned.

The balls themselves wear very evenly. Oblique forms in normal practice cannot exist.

(To be continued.)

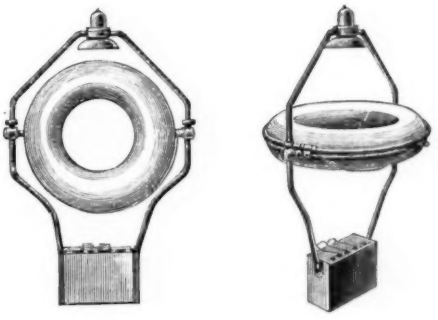
THE GUEST-BATES ELECTRIC LIFE BUOY.

The following illustration which we have culled from the New York *Electrical Engineer*, represents a novel electric life buoy, which has been tested on board the lighthouse tender *Armeria*, Commander West, United States Navy, and favourably reported upon to the Lighthouse Board.

The buoy consists of a ring mounted in a framework of metal tubing. The ring is normally in the plane of the frame. When the buoy is dropped into the water the ring on which the buoy floats turns so as to rest with its side on the water, and on so turning operates an automatic switch controlling the lights in the manner described later. At the lower end of the frame is the battery box, containing the cells. To keep this perfectly dry inside, a moisture absorber is placed there with the cells. The box cover is easily removable and made water-tight by a packing of rubber with wax or tar. The framework passes from the ends of the battery box upward, meeting to form an arch above the ring. On top of this arch is the lantern, a glass globe covering one or more pairs of incandescent lamps. Electrical connection between these lamps and battery cells are through the tubes of the framework on both sides. On each side of the frame is a switch box containing the automatic switch controlling the circuit.

The ring is mounted upon trunnions journaled in the switch boxes. Where the trunnion enters the switch box it is surrounded by a water-tight stuffing box to better protect the switch. The stationary contacts of the switch are secured to the frame and box and the movable contacts are secured to the ring trunnions, but, of course, both sets of contacts are insulated from their supports. These contacts are so related to each other that the turning of the ring but a very small angle out of the plane of the frame will close the circuit and light the lamps, which will remain in circuit until the ring can be turned around nearly one complete revolution. This precaution is very important, because it insures the continuous glow of the lamps in a rough sea.

Such are the principal features of the machine. There are a few other interesting details added. One is a hand switch concentric with the lantern, added merely for precaution. It is so arranged as to be able to switch on one pair of lamps at a time, or turn off all of them. The lamps are in parallel and are used two at a time to economise battery power. If one lamp of any given pair gives out the other can supplement it until another pair of lamps can be switched on. Another addition is a bell below the lantern, automatic or other, which will be of value as a fog signal. The handle of the hand switch is surrounded by a water-tight stuffing box, like that of the automatic switch.



A very interesting problem here is that of battery power. The lamps will be from 3 to 8 volts, from ½ to 8, or more, candle power, and in every case will take about 1 ampere of current. The improvements in dry batteries of late years have been so great that the market can now furnish cells of which six in multiple series of three can glow continuously a couple of 1 candle-power lamps one hour. Connected in the same way, 18 such cells can glow these lamps three hours, and 36 of them can glow the same lamp six hours. More hours can be gained by adding cells, but the latter case will be amply sufficient for most work. For lamps of large candle power for use a longer time a storage battery is at present recommended, having easy access to a dynamo to charge them up every two or three months. Accumulators are now so well made that they will lose but 20 per cent. of their charge by standing in a place kept dry as the buoy battery box will be. Hence, on a steamer which almost always has its dynamo, the care of cells is an easy matter. There is now being designed a salt water battery of such power that it will glow a strong light for several whole nights continuously when overboard, its capacity being large, without occupying much room.

The Guest-Bates device is being exploited by the Guest-Bates Marine Life Saving Appliance Company, of New York.

D

THE STUDENTS' CONVERSAZIONE AT FINSBURY COLLEGE.

This function came off very successfully at the Technical College, Finsbury, on the evening of Thursday the 20th. The rooms, laboratories, and workshops of the college, besides the ordinary machinery and apparatus, contained a large and interesting collection of exhibits lent for the occasion by some of the leading chemical and electrical firms. We noticed, among others, Messrs. Crompton & Co.'s electric cooking and heating apparatus, and a working exhibit of an automatic electric welder, and samples of electric welding by the Electric Welding Company. The automatic welder was shown rapidly welding together pieces of steel wire about one-eighth of an inch thick by pressing the ends of the two pieces of wire together, while a current of 9 or 10 amperes was passing across the joint. The rapidity and certainty with which butt welded joints were produced was amazing, when compared with the best that can be done by the venerable art of the village blacksmith. The samples of electric welding exhibited showed that many welds are rendered possible by this process which were impossible by the old process; in fact, there can be no doubt that electric welding will cause a revolution in many departments of metal working. They also exhibited a very fine selection of samples welded by the Thomson process. Among the most interesting specimens were some carriage tyre sections that can only be welded electrically; printers' chases in all sizes and varieties; iron and steel tubes butt welded; samples of welded iron rod, bent double at the weld, without cracking, and a good assortment of chains from key chains to massive iron chains; also, and by no means the least interesting exhibit, a unique collection of welds made on finished gun parts, the latter being quite a new departure. The process was demonstrated by the engineer of the company, Mr. Reginald J. Wallis-Jones.

The attraction of the evening was the lecture on "Invisible Light and its Photography," by Prof. S. P. Thompson. The interest in the subject was so great that the lecture had to be delivered twice. Prof. Thompson expounded the subject in his well-known lucid and facile style. After a rapid survey of the nature of light as we have hitherto understood it, he proceeded to show how the new radiation was produced. The gradual change of the appearance of the electric discharge in a tube as the rarefaction increased was very beautifully shown. A long glass tube, with thick wire electrodes projecting into it from each end, was exhausted by an air pump driven by an electromotor, while the discharge from a large induction coil was being passed through it. The gradual spreading of the glow light over the cathode, the stratification of the luminosity in the tube, and the formation of the dark space were very beautifully exhibited to the audience. The leading phenomena exhibited by Crookes tubes were experimentally illustrated, and, finally, the recent discoveries of Lenard and Röntgen were described. The recently discovered power of the X rays to discharge electrified bodies, whether positively or negatively charged, was shown by placing a Crookes tube opposite an aperture in a sheet of lead and allowing the X rays to fall on a disc of zinc fixed on the rod of an electroscope. The probable nature of the X rays was then ably discussed in the light of our present experimental knowledge, and we were pleased to find that the learned professor supported the view which we, in our wisdom, have advocated, that Röntgen and Lenard rays are simply two different names for the same thing, namely, cathode rays that have passed outside the tube. Professor Thompson leans to the view that this new radiation is of the nature of longitudinal waves.

ENGLISH ELECTRIC RAILWAY COSTS.

To analyse the accounts of an English tramway company for the purpose of ascertaining the exact working costs, would be, in many cases, an almost impossible task. Apparently, a tramway company is not compelled by the legislature to set forth its figures in such a manner that he who runs may read. Hence it may arise that when electric tramways have become established in this country, one may find it difficult to obtain the actual cost per car mile. Although there are many electric tramways established throughout Europe, few of them will furnish statements as to what it costs to run their cars. It may be diffidence that leads them to adopt this course. We know that, in many cases, it does not arise from the figures being otherwise than satisfactory, so far as the electrical working is concerned. The paucity of figures, at the present stage of electrical tramway development, is much to be regretted. But where electric propulsion is adopted in this country for purely railway work, then there is a possibility that one may obtain real information as to working costs, for all railway companies, whether electrical or otherwise, must make up their accounts in the manner prescribed by the Board of Trade. A railway company's statement of accounts is like a "Bradshaw's Guide," its intricacy is more apparent than real. The recently published accounts of the Liverpool Overhead Railway and the City and South London Railway Companies, which have been recently noted in these columns, are quite worthy of a more detailed consideration than they usually receive. It is hardly necessary to point out that the only point of semblance between the two lines is the electrical propulsion. True, they have many characteristics in common which appertain to ordinary railway practice, but to illustrate the difference between running trains through underground tunnels, which are unaffected by climatic changes, and propelling trains on an overhead structure, subject to many changeable conditions, it is only necessary to refer to cost of maintenance of way, works, &c. For a train mileage of 321,417 the Liverpool line spent £3,619 in the latter half of 1895, while the City and South London with 227,350 train miles cost £462; it is true that the South London line is just about half the length of the Liverpool Overhead; but that would not account for the difference of eight times the cost. As a matter of fact, very considerable sums are spent by the Liverpool Company in operating swing bridges across the docks; the repairs of structure and opening bridges alone absorbing £1,240. Before proceeding further it would be as well to give a table setting forth the cost per train mile on the two lines for corresponding periods.

Cost Per Train Mile.

	City and South London Railway.		Liverpool Overhead Railway.	
	1894.	1895.	1894.	1895.
Maintenance of way, works, &c.	·54	·48	1·99	2·63
Locomotive and generating power	6·02	6·0	3·23	3·61
Traffic expenses	5·95	5·85	5·07	4·94
General charges	1·73	1·71	1·52	1·53
	14·62	14·51	11·98	12·92

It will be seen that the cost of loco and generating power is very much less on the overhead than on the underground line. The sum spent in this department by the Liverpool line stands at £4,921, against £5,707 on the South London system. The lower cost per train mile is, of course, partly accounted for by the heavier train mileage on the overhead line, for certain charges under this heading would not be increased on the South London line if more trains were run. The principal sum is in connection with wages for working generating engines and motors, the difference between the two systems being only about £13. We may always expect coal to figure somewhat largely in running expenses of London lines, and it is doubtful whether they will ever be quite as low as at Liverpool, although it may be expected that there would be, occasionally, greater losses of power on an electric railway worked in the open. But all things considered, we may reasonably doubt whether an increased train mileage on the City line would have brought down the cost to anything like the favourable figure obtained at Liverpool. What we have said about the power expenses applies equally to "traffic expenses." This item on both lines is very much the same, and there would be probably a slight reduction in the case of the City Company if more trains were run. In justice to the company, however, it should be mentioned that a considerable amount is included in this item for hydraulic power for lifts.

It is not easy to discover the number of passengers carried per train mile on both lines, but the receipts are a little curious.

	1894.	1895.
Liverpool Overhead ...	18d.	22d.
City and South London ...	24d.	25d.

While the City line obtains a considerably higher sum per

mile, the increase in receipts per train mile on the Liverpool system are most marked. It would be difficult to understand if the City company's receipts were not higher than those at Liverpool, for a comparison between the two neighbourhoods would show that while the Liverpool Company traverse occasionally somewhat thinly populated districts, the South London line passes through densely populated neighbourhoods; but, as we have often said before, the City line will not be worked to the best advantage until the line is extended much beyond its present limits.

Notwithstanding the fact that the total expenses of operating the Liverpool overhead line is 12·92d., the economical nature of electric propulsion is placed beyond a doubt. The cost of working the line will compare favourably with the best managed steam locomotive system. It is not easy, of course, to apply the figures to tramway practice, indeed, conditions are so absolutely foreign to what obtains in ordinary streets that it would be useless to make the attempt, but it is not too much to say that the figures relating to cost of generating power would form no bad argument for electric traction on ordinary tram-lines.

CORRESPONDENCE.

Electric Lifts.

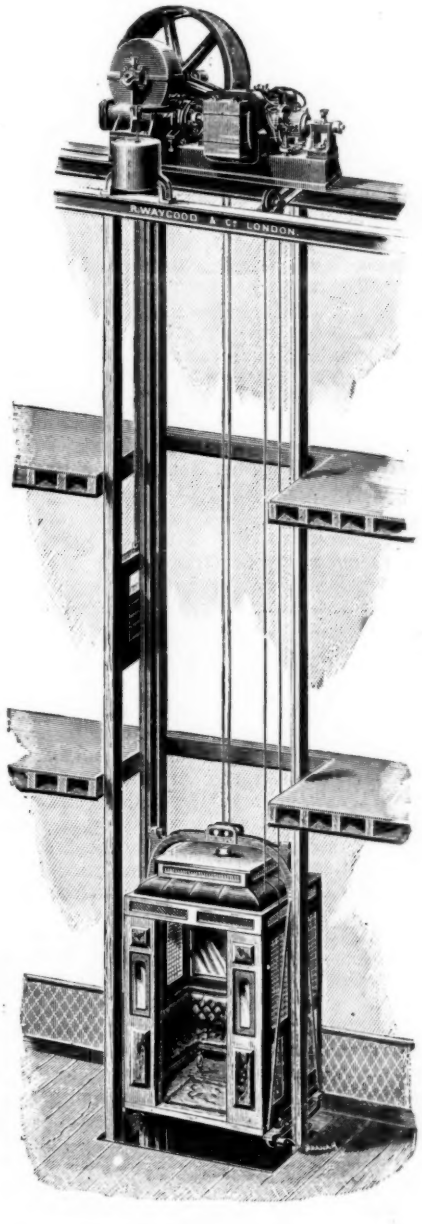
Having read with interest the article published in your issue of the 21st inst., by Mr. W. A. Gibson, on "The Otis Electric Lift," and considering the general interest manifested in the subject at the present time, perhaps a short description of an equally successful electric lift, manufactured by ourselves, might be of interest to your readers. Some years ago we recognised the great future in store for this class of lift, and we at once set to work to develop this branch of our business, and though—as Mr. Gibson infers—there *are* people who still have a prejudice against lifts, and are yet inclined to regard electric lifts as an experiment; still this prejudice is undoubtedly being swept away by the ocular demonstration of a rapidly increasing number of lifts, far removed from the range of experiment, which are doing good and useful work most successfully, economically, and with but small repairs.

We heartily agree with the drift of Mr. Gibson's remarks, that a common or ordinary kind of motor attached to an ordinary winding gear, will not make the most satisfactory form of electric lift; but every detail of motor, switch and gear in combination requires to be carefully considered in relation to this special work. From the result of much labour we claim to have produced an electric lift which complies with all the conditions necessary to thoroughly satisfactory working, and which has—owing to our particular system of switching arrangements—an unusual amount of adaptibility which enables us to overcome bad structural difficulties in places where we are installing our lifts; while our mechanical design and system of manufacture permit us to supply this highly economical type of lift at a price not seriously in advance in price of hydraulic.

The general design of our lift apparatus is very similar to that described by our friend, Mr. Gibson, the motor being specially constructed, of inverted type, with Gramme-wound armature, special holders for carbon brushes, and perfect self-oiling arrangements; the shaft is coupled directly to steel worm, through carefully insulated coupling, which is so designed and utilised to form pulley for a neat toggle brake. This brake is operated by the same movement of hand-rope (passing down through cage and lift well), which controls the starting switch.

The operations of our starting switch follow the same cycle as that described by Mr. Gibson, the greatest point of difference being that our automatic slow starting device is not controlled by a solenoid, but by gravity acting against an air dash-pot, adjustable as to speed. The rheostat which it actuates is shaped like the commutator of a dynamo, and is divided into a number of segments, which consequently give perfect smoothness in starting and prevent any excessive rush of current. For stopping lift automatically at top and bottom of travel, we have discarded the screw and nut arrangement, and depend in actual practice upon the steel wire (hemp covered) hand rope; but should this rope break from any cause, we have in the well-hole two tappet switches, permanently fixed, which divide the main circuit (and upon one of which the cage itself would engage before any damage could be done), cutting off the current for that particular direction in which it is travelling, and thus bringing the lift to rest.

By these means we are enabled to use a grip sheave for working the cage, instead of grooved hauling drum, in such situations where a hauling drum would involve grave difficulties. The gearing is composed of an accurately cut phosphor bronze or gun-metal worm-wheel of large diameter securely connected to the hauling drum or sheave, and



enclosed in cast-iron bracket, which forms an oil bath, in which the turned steel worm rotates. The thrust of the worm is taken in both directions, by specially designed ball, thrust-collars of steel, hardened and ground, proper adjustment for wear being provided at both ends. The whole combination of switch, motor, and gearing, is mounted on one massive cast-iron bed-plate, which may be fixed either at the bottom or top of the well hole, or even any level in close proximity to it. That the electric lift has come to stay, we can testify by pointing to our shops overflowing with work, no less than 11 orders having been taken recently for lifts varying from 3 cwt. to 2 tons carrying

capacity, and we continue to receive cuttings from local papers in Cape Town and elsewhere, describing the success of lifts we have exported.

We trust you will accept our apologies for encroaching upon your good nature by asking you to kindly find space in your valuable columns for the foregoing, and beg to remain,

R. Waygood & Co., Limited.

Falmouth Road, S.E.,
February 26th, 1896.

The Wiring Question.

As a member of the Electrical Trades Union I should deem it a favour if you would grant me space to reply to "Mac" *re* "Done for work in London," "Incompetent Union Workmen," and being warned against becoming a member of the E.T.U.

In the first place I should advise "Mac" to become a member of the E.T.U. before he again writes and not write about that which he knows nothing of. I can assure "Mac" that the London members are working in London, and not "on some unknown island where there aint no people."

Also I should like "Mac" to prove that there is a body of non-unionists who are obtaining as high a rate of pay as the members of the E.T.U. Also, for him to prove that our out-of-work members are higher than the non-unionist. I can assure "Mac" that our rate of pay is higher. Also that our out-of-work members are less than the non-unionist.

Therefore, it clearly proves the E.T.U. men, if not fully competent, cannot be the worst men in the electrical industry.

Also, I should like to know who the friend and adviser of "Mac" is, no doubt he knows about as much of the E.T.U. as "Mac" does, or perhaps the E.T.U. knows something of him which would debar him from becoming a member, as only competent, trustworthy, honest, and sober men are eligible for admission.

A. Calipé.

February 25th, 1896.

P.S.—I should deem it a favour if "Mac," or any of a like mind, would meet by appointment the officials of the E.T.U. at the General Secretary's offices, Club Union Buildings, Clerkenwell Road, when, no doubt, a satisfactory answer could be obtained to all queries.

Replying to "Mac," in your issue of the 21st, he states that he and many other of his friends have been warned not to join the ranks of the Electrical Trades Union; perhaps he is like a great many men in London, not competent enough to join, and throws the responsibility upon employers.

I am in a position to deny his statement regarding union men being all incompetent, I have in front of me at the present moment over 100 letters from some of the most important firms in London and the provinces, asking the union to supply them with men.

Now, "Mac," if you are possessed of a very small amount of common sense you must know that when firms write asking to be supplied with men they know what they are doing.

The E.T.U. is registered by Act of Parliament; if you were an employer of labour, and asked us to supply you with a particular class of workman and we sent a duffer, you must know who would be responsible for any loss or damage done by the union man. We have been established some few years now, and up to date have not received a single complaint from any employer who has asked us to supply them with men.

Regarding the foremen being great sinners, I contend that the men themselves are to blame for not being amalgamated; if you doubt my statement take a quiet walk round and have a look at some of our federated jobs, you will very quickly alter your mind.

I maintain that electric lighting cannot be done by other trades, as it requires a certain amount of knowledge that cannot be bought or picked up out of penny novels. If you have the least doubt on your mind, try and become a member of our union, you will then find that we have amongst our members some of the most practical men that can be found, and well up in theory, with 14 or 15 years' experience—men who have a knowledge of all classes of electric work, such as erecting complete plants, telephone stations, bells and installations.

If employers cannot spare time to write a post-card stating their wants to our general secretary, Mr. R. Steadman, Electrical Trades Union, Club Union Buildings, Clerkenwell Road, E.C., they ought to put up with the abuse that is thrown at them through incompetent workmanship. Arc lamps and other goods would not be sent here from Germany if you were to use your vote in a proper manner. Arc lamps can be made in England and sold at a much lower figure than German made arc lamps.

I am afraid I am trespassing too much to go any further into your other questions. Kindly pay us a visit on our next meeting night and I will be pleased to show you letters from firms who have employed union men and are thoroughly satisfied.

115

Electricity in Medicine.

I believe no other journal in this country gives us reports of the progress in other countries (or even in our own) in the subject indicated above, as you do from time to time, but which I think must transform those of your numerous readers who are interested in this valuable application of electricity, into temporary Oliver Twists, causing us to hunger and thirst for *more* information. But without further beating about, can you kindly give us, or tell us where to obtain more *detailed* accounts of the interesting papers read before the annual meetings of the American and Canadian Electro-therapeutic Associations outlined in your issues of November 1st, 1895, and January 3rd, 1896.

And I would further ask, is it possible to obtain details (dimensions, &c.) of the apparatus employed by Dr. Apostoli and others in the application of the "high frequency" currents (solenoidal system), *à la D'Arsonval*, the excellencies of which were duly reported in the Electrical Review of December 27th last, and in other issues.

Arthur C. Hattatt.

Southampton, February 25th, 1896.

[Probably the Secretaries of the Associations will oblige our correspondent.—Eds. Elec. Rev.]

Cable Defence Scheme.

Sketch of hydraulic installation on a 6,000-ton cruiser, operating in water not exceeding 100 fathoms in depth.

Fig. 1 is a section; fig. 2, plan (enlarged) of pipe connections; fig. 3 a suggestion for "pneumatic" pulleys. Similar letters in figs. 2 and 3 refer to similar parts.

The tank carries drum, A, which is 15½ feet long between flanges, 15 feet diameter when full; core 6 feet diameter, and journals, say, 20 inches diameter and 31 inches long. This drum of 2,300 cubic feet capacity is smaller than a single double-ended boiler of some mail boats, and the strain on the bearings is not an abnormal one in heavy engineering

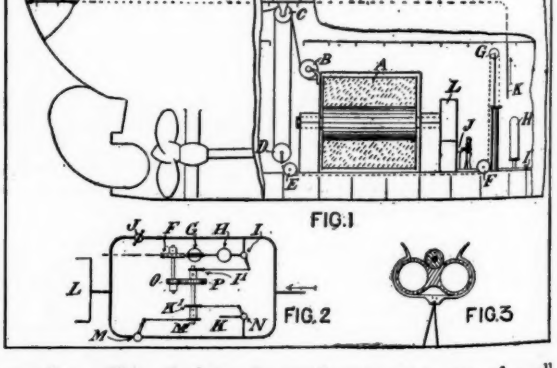


FIG. 1

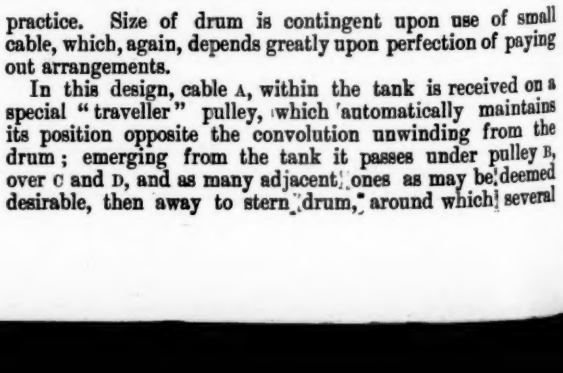


FIG. 2 FIG. 3

practice. Size of drum is contingent upon use of small cable, which, again, depends greatly upon perfection of paying out arrangements.

In this design, cable A, within the tank is received on a special "traveller" pulley, which automatically maintains its position opposite the convolution unwinding from the drum; emerging from the tank it passes under pulley B, over C and D, and as many adjacent ones as may be deemed desirable, then away to stern drum, around which several

turns are taken, and overboard. A chain is connected at D, and, passing under E and F (this is a sprocket wheel), it is led over sheave G at head of hydraulic ram and made fast, as shown. Ram in actual practice would be shorter with more sheaves. Referring to fig. 2, sprocket wheel, F, actuates through pinion, O, and spur wheel, P, a shaft fitted with cams, I^1, K^1, and M^1, controlling water supply respectively to the ram, the small motor at stern drum, and a byepass, M, to the main engine. Suppose the position of mechanism to be as in fig. 1, the valve, I, will have been closed by cam, I^1, and the elevated position of the ram will be dependent upon the pressure in air vessel, H. In the upward movement of the ram, however, it, also, through cam, K^1, opened valve, N, and communicated by pipe, K (shown, broken, in fig. 1), with the small motor on the stern drum, putting, therefore, a certain tension upon the cable.

If, now, valve J be opened, and main motor, L, be started, all cable delivered will be thrown overboard. This is a condition of minimum tension, and obtains at vessel's highest speed if speed of drum exceeds vessel's rate over sea bottom; if, however, through error of judgment insufficient cable is being received from the main drum, a gradually increasing strain must eventually come upon the cable, this causes the ram to be depressed, air pressure in vessel H rising accordingly. At a certain point in this downward travel of the ram its valve, I, is again opened, putting it once more in communication with the main water supply, also, by the same movement, the water supply to the stern drum motor is cut off at valve N. If driver has failed to increase engine speed after seeing the ram movement, its continuation is caused to open valve, M, through cam, M^1, whereby the power supply to the motor, L, is augmented until the increased speed meets the demand. Thus a prearranged maximum tension is reached, and if driver entirely shut off his hand valve it would not affect the tension. As he opens up his valve, of course the byepass will be closed automatically. In winding in cable, cams M^1 and K^1 may be thrown out of action, tension being indicated by the pressure gauge on the ram.

The motor at the stern drum would drive through a ratchet wheel arrangement, so that the drum could travel faster, or respond to a quick pull without having to await change of speed in mechanism. All revolving parts should be light yet strong; pulleys might be on suspension plan, as in cycle wheels. Driver would receive his instructions by standard revolution indicator, at which indicated speed it would be his duty to maintain his own counter.

In a few words it may be said that this arrangement of mechanism handles the cable with "tenderness," and delivers it with any percentage of slack that may be wished; yet inboard, the tension cannot fall below or rise above prearranged amounts. Refilling with cable may be performed at sea, or in port, with great rapidity, and, if not exactly perfect, the design goes a long way towards making possible the use of cable equipped scouts, the value of which in war time could not be over estimated.

C. Scott Snell.

London, *February 24th*, 1896.

The Blot Accumulator.

Is the *Blot* secondary cell (why *do* you call it an "accumulator"?) what was known as *de Kabath's* in 1882?

The description given in Electrical Review of the 14th inst., would seem to apply exactly to cells which I saw being made up at Mons. de Kabath's factory in Paris, 14 years ago. Mr. Maxim was with me at the time, so the date can be fixed if necessary.

Wm. H. Massey.

February 24th, 1896.

Single-Split Transformer Plates.

With reference to the transformer plate illustrated by Mr. Adams on page 205 of your issue of last week, it may be of interest to know that this form of plate is already eight years old. It was patented in this country on March 8th, 1888, No. 3,590 of that year, by Mr. J. G. Statter.

J. G. Lorrain.

February 22nd, 1896.

Concentric Cables v. Bare Strip.

In yours of 21st, a writer, describing Manchester Works, commits himself to the statement that it is an "absolute impossibility" to make a connection to a concentric cable while current is passing. Where can he have lived? The thing is done every day in this England of ours, and I shall be pleased to show the way if your correspondent is desirous of being just to concentric cables, and of feeling the joy which the engineering mind experiences in finding the "absolutely impossible" once more yielding to proper treatment.

J. H.

THE DEVELOPMENT OF ELECTRICAL TRACTION APPARATUS.*

By H. F. PARSHALL.

In this paper I propose to discuss and illustrate the more important details of the machinery especially developed for use in electrical traction.

At the commencement of the writer's experience, about six months was taken to construct 40 street car motors. At the present day, in the same works, there are constructed regularly 150 street car motors per week, and, in some cases of extreme demand, as many as 500 street car motors have been constructed in a single week.

The difficulties experienced with the apparatus, as first manufactured, were largely confined to the motor and motor regulator, this latter being now commonly called the controller. After these had been brought into a better state of perfection, refinements were introduced in the power station, and in the switching appliances. This being the order of development, it will also be taken as the order for discussion.

The tramway motors first constructed in the United States were but little suited for the work of electrical traction. Engineers but little understood the great strain, both mechanical and electrical, to which this machinery would be subjected. In general, the motors were designed on much the same lines as central station dynamos and stationary motors had previously been. The speed, the work, and the torque, at different speeds of the motors, in general, did not agree to the speed and resistance of the car at different speeds. Special attention was paid to the efficiency at full load, but, inasmuch as the mean working point was greatly less than the full load of the motor, efficient results were not obtained until power measurements as to the average work required for the propulsion of a car were made, and the motor so designed that the efficiency was towards a maximum at the average working point of the motor.

Another point that was not clearly recognised related to the torque per ampere best suited to such a motor. In starting the car, the torque per ampere should be a maximum. As the car becomes accelerated, the torque per ampere requires to be less, and should fall off according to the maximum speed to be attained. In the first motors the torque per ampere, owing to the proportions of the motor, was approximately constant, so that an excessive starting current was required, this being so great that, frequently, there was a great heating of the windings, and the durability of the motor was greatly impaired. At the present day, in well-designed street car motors, the effort at the car wheel is about 40 lbs. per ampere in the armature, and, when running at full speed, from 20 to 25 lbs. In thus varying the range of torque per ampere, the efficiency of the motor has been increased, and, likewise, the durability of the parts in which the electrical losses occur.

The mechanical improvements found necessary were numerous and important. The diameter of the shaft had to be increased, so that the factor of strength was some six times greater than that in ordinary station motors and dynamos; the bearings had to be increased in length and diameter; and the face of the gear had to be increased, and also the pitch. The fine pitch that had previously been found satisfactory in machine construction was found to be altogether unsuited for tramway motors.

Improvements were also made in the method of holding the armature conductors, since it was found that the conductors, when held in the ordinary way, would shift in respect to each other, and so injure the insulation as to impair the durability of the armature.

In order to lessen the deterioration of the controlling mechanism, which is either a commutating switch or a rheostat, it was found necessary to design the motor so that the torque per ampere, at a given speed, coincided with the resistance of the car for a given acceleration and speed. Increasing the efficiency of the motor, that is, lessening the amount of current for which a given torque and acceleration was produced, greatly lessened the deterioration of the controlling apparatus, so that advancement in the design and efficiency of the motor was accompanied with a corresponding durability of the controlling apparatus.

The next more important step in this direction was the substitution of the multipolar motor, and the dispensing with one set of gears. This was found practicable to do when the manufacture of steel had advanced so that castings of high permeability, and of the complex form required for tramway motors, could be made. The earlier types of motors were made of forgings of simple shape, which were not of such form as could be well made into multipolar motors. This last change was accompanied by numerous other mechanical improve-

* Paper read before the Foreign and Colonial Section of the Society of Arts on February 18th, 1896.

ments. The gears, shaft, and bearings, were again increased in size. The method of lubrication was improved, the gears being placed in an oil-tight box, so that their durability was increased some three or four times. A steel gear will now wear for three years, and a pinion nine months, in an equipment making 100 miles a day. The pinions usually have 13 to 16 teeth, and the gear from 60 to 70. The pitch commonly used is that known, in the United States, as the No. 3 pitch, *i.e.*, the diameter of the gear, in inches, divided into a number of teeth = 3. By making the shaft more rigid, and by studying the form and clearance of the teeth, a gear has now been produced that makes comparatively little noise.

Another improvement relates to the method of suspending the motor. In the so-called "nose-suspension" method, in which the motor is carried by a lug and cross-bar, the top axle lining lasts about six months, and the bottom axle lining about 12 months. *With the side-bar suspension*, in which the motor is suspended in a line vertically underneath its centre of gravity, the axle linings last twice as long.

Great mechanical improvements have also been made in the construction of the commutator, which is subjected to hard usage, owing to the necessity of carbon brushes (set at a very considerable pressure on account of the vibration of the motor). A well constructed motor may now be expected to last two years.

A further improvement has been to completely house the motor in a steel casing, so that it is now entirely waterproof. The force with which water penetrates a tramway motor in a wet street is remarkable, since the joints between the upper and lower halves of the motor have to be especially larded, to keep the water from oozing through, even when the surfaces are as perfectly milled and fitted together as possible. The electrical features of the motor have also received a decided mechanical improvement. The armature coils are formed and interchangeable, and insulated, first, with asbestos, and, secondly, with mica and tape, so that an armature coil is calculated to withstand a very high temperature. The method of securing the armature coils has also formed the subject of study and improvement. The coils are now held upon a conical surface, and securely clamped by a nut, so that any motion is prevented.

Another improvement is in reference to the magnet coils, which are insulated with asbestos, and made entirely waterproof. It would seem, perhaps, that this was unnecessary, considering that the motor itself was made waterproof; but the way the condensation of water frequently occurs in an encased motor, renders it necessary that both the coils of the field and of the armature should be waterproof for good results.

Another improvement that has been found of great importance in practice, is the diminution of the weight of the motor for a given power. This has been done by the use of steel, and by studying particularly, the mechanical construction, and the nature of the work to be done. A motor nominally rated as 25 H.P., complete with the gearing, now weighs about 1,500 lbs. Such a motor cannot, of course, do 25 H.P. permanently, but it is rated on its capacity for doing this work for a limited period of time, generally two hours, this being a more satisfactory manner of rating for electrical traction. With this diminution of weight, it has been found that the deterioration of tracks, trucks, and bearings, has been greatly lessened. Great improvements have also been made in the construction of trucks for tramway purposes.

The motor that has heretofore been illustrated, and particularly discussed, is what is known as the "standard tramway motor," *i.e.*, a motor capable of exerting 800 to 1,000 lbs. horizontal effort on the car wheel, when running 10½ miles per hour and delivering 25 H.P. when mounted on 33-inch wheels and loaded to its rated capacity. It differs only in the point of size from the larger motors that are used in what may be termed "light railways," along which trains weighing from 60 to 100 tons are moved at a speed of 15 to 45 miles an hour, and, in some cases, to 60 miles a hour.

TABLE OF HORIZONTAL EFFORTS AND TRACTION COEFFICIENTS.

Output at full load.				Output required to drive loaded train on a level.‡		
Turns per coil on armature.	Horizontal effort for equipment in lbs.	Speed in miles per hour.	Total H.P. of equipment.	Horizontal effort for equipment in lbs.	Speed in miles per hour.	Total H.P. of equipment.
3	1,600	13·5	60	220*	26	16
4	1,600	10·5	50	220*	23	14
2	2,400	17·5	110	450†	28	34
3	2,400	12·0	80	450†	20	24
4	2,400	9·5	60	450†	18	22
2	4,000	10·5	110	600	18	29

* 20 lbs. per ton for 11 ton train.
† 15 lbs. per ton for 30 ton train; 10 lbs. per ton for 120 ton train.
‡ The output required by train on a level will vary within wide limits, with cars of varying weights and track in varying conditions.

In the standard motor, the diameter of the car axle is 3⅜ inches; the pinion is seated with paper bore; the axle gear is of cast-iron; and the gear reduction is 4·78 to 1. This motor is suited for all ordinary city tramways. It has been frequently wound for a higher speed and different output, but the consumption of energy in a given time is increased according to the increase of speed, that is, the consumption of energy per car mile, in a given motor, remains practically the same, so long as the same magnetic conditions remain constant. In high speed, or suburban railway work, where heavy grades and heavy loads have to be met with and drawn from 20 to 30 miles an hour, a motor having a rated horizontal effort of 2,000 lbs. when running 12 miles an hour and delivering 40 H.P. under the previous mentioned conditions, is commonly used. For a still heavier class of work, two or four motors are used per train, each giving 2,000 lbs. horizontal effort when running 20 miles a hour, and delivering approximately 120 H.P. under the previously mentioned conditions. Two such motors will operate three ordinary passenger cars at a speed of 30 to 40 miles an hour, and four of them operate six passenger cars. It is interesting to note that, in the design of these motors, the maximum rated horizontal effort is not varied by varying the number of turns on the armature, so long as the weight of the copper and the magnetic flux remains the same. I give herewith a table that shows the general results and traction coefficients that have been obtained in the United States with the forms of equipment with which I am familiar.

Referring next to the controller, I may state that this has, undoubtedly, required as much attention and invention to perfect as the motor. The controller that is now generally used is known as the "series parallel controller," *i.e.*, the motors are started in series with each other. This lessens the starting current for a given torque to half of that when the motors started together in parallel. It has been found that, in cities where the number of stops are frequent, by the use of the series parallel controller, the consumption of energy per car is lessened 40 per cent. Of course, there would be no such gain in suburban districts, where the stops are less frequent. The different steps gone through in the starting of two motors by the series parallel method are as follows:—

The two motors are started with external resistance in, which is gradually turned out of circuit. One of the motors is shunted with a varying resistance until short circuited. It is then open circuited with respect to the other motor, and, by means of varying resistances, the motor is finally brought into parallel with the second motor.

(To be continued.)

LEGAL.

MESSRS. J. HOPKINSON & CO., LIMITED, AND MESSRS. J. DEWRANCE AND CO. *v.* BALDWIN.

THIS action came before Mr. Justice North, in the Huddersfield High Court of Justice, on 14th inst. It was brought by Messrs. J. Hopkinson & Co., Limited, of Britannia Works, Huddersfield, and of Queen Victoria Street, London, jointly with Messrs. J. Dewrance & Co., of Great Dover Street, London, engineers, to restrain the defendant, a brass founder, at Devonshire Brass Works, Keighley, from infringing the joint patent rights of the plaintiffs, which they have united to maintain for the manufacture of improved water gauges. Mr. R. W. Wallace, Q.C., and Mr. Arthur Pagett (instructed by Messrs. Learoyd and Co.), appeared for the plaintiffs. The evidence showed the patent rights had become well established, and were in use by the Admiralty and the largest steam users throughout the country, that the defendant had recently commenced to make gauges having within them the principles of the patents of the plaintiffs, and that he was advertising them and supplying them to the trade. The defendant was perpetually restrained from continuing to infringe. He was ordered to withdraw all infringements from his customers and his advertisements, to hand over his catalogues and drawings to the plaintiffs' solicitors for destruction, to deliver to the plaintiffs all infringing gauges, and to pay the costs of the action.

LAZARE, WEILLER & CO. *v.* BOLTON & SONS

BEFORE Mr. Justice Mathew, last week, this case, which was tried before his Lordship a few weeks ago, came again before the Court for the assessment of damages.

Mr. JOSEPH WALTON, Q.C., for the plaintiffs, said the actual net profit which the plaintiffs would have made upon the contract was £5 per ton. Since June, 1895, the date of the breach of contract, the plaintiffs had only sold 83 tons per month, at a loss of £2 per ton. In five years that would be £9,960. Then there was a loss of £5 a ton upon the balance unsold—namely, 7,220 tons, and a loss of profit of £35,100. That was the basis upon which he estimated the damages.

SIR EDWARD CLARKE, Q.C., for the defendants, said: The bargain was that the plaintiffs were to make some concession in order to beat down foreign competition. They had not done so, and the contract came to an end. There were matters of principle to be decided first upon appeal before they went into the elaborate inquiry as to damages.

It was agreed that the question of damages had better be reserved until the questions of principle had been decided in the Court of Appeal.

RYALL'S TRUSTEES *v.* THE CENTRAL LONDON RAILWAY COMPANY.

AT the Sheriffs' Court on Thursday last week, before Mr. Under-Sheriff Burchell and a special jury. The question involved was the amount of compensation to be paid to the trustees for the premises situated at 31, Holborn, required by the railway company for the construction of a station, the amount claimed being £6,216. Witnesses were called by the respondents, who valued the property at £4,400, equivalent to 25 years' purchase. The jury assessed the compensation at £5,430.

BUSINESS NOTICES, &c.

Agency.—Messrs. D. H. Bonnella & Son, of 58, Mortimer Street, Cavendish Square, W., have acquired the sole agency for the United Kingdom for the sale of the patent bead ray diffusers, in succession to Messrs. Bashall & Overton.

A Press Directory.—*Sell's World's Press and Advertiser's Reference Book* has now reached its sixteenth year of publication. The total number of pages is over 1,200, the book being bound in thick yellow boards with black printing, and, so far as bulk goes, there is plenty for the money (2s.). We fully appreciate the difficulties encountered to render a directory of any kind absolutely correct in every detail, but we would remark that a cursory glance shows there are a number of errors, and it is difficult to see how some of them have arisen. For instance, the Electrical Review is stated to be published on Saturday instead of Friday; a sixpenny electrical contemporary published on Friday is described thus: "Saturday 4d."; a monthly magazine which ceased publication in London over twelve months ago is stated to be still appearing. The details regarding the New York electrical journals are very incomplete; only three are honoured with mention, the names of two of these being wrongly rendered. Our review of this work can only refer to the electrical information, which we regret having to sum up as needing careful revision. It is only fair to say, however, that the general literary information and the special articles, which are a regular feature of the book, are exceedingly instructive and interesting, particularly that relating to the law of libel.

Business Announcement.—We are informed that the business hitherto carried on under the style of J. D. F. Andrews & Co., at 15, Marsham Street, and temporarily at 34, Victoria Street, has been purchased by the Safety Concentric Wiring Company, who have bought outright the whole of the goodwill, all the patents, stock-in-trade, fixtures, &c., of the business hitherto carried on by J. D. F. Andrews & Co., and that Mr. J. D. F. Andrews has now no longer any connection of any kind with the firm, goodwill, or patents. As stated last week, Mr. Andrews has opened an establishment elsewhere.

Bankruptcy Proceedings.—Notice is published in the *London Gazette* of the release, dated February 5th, of Geo. Wreford, trustee and senior official receiver, in *re* Walter Andreae, electrical engineer, of Fulham.

Dissolution of Partnership. — Messrs. J. Cooper and G. S. Pannett, who have hitherto carried on the business of gas and electric light fitters and plumbers at 82, Newman Street, Oxford Street, W., and 333, Gray's Inn Road, W.C., as Cooper & Pannett, have dissolved partnership by mutual consent. Debts in respect of the Newman Street business will be attended to by G. S. Pannett, who will continue that branch on his own account, whereas debts in respect of the Gray's Inn Road branch will be attended to by J. Cooper, who will continue that branch on his own account.

Liquidation Notices.—The *London Gazette* announces that a general meeting of the Edison Electric Light Company will be held at 44, Gresham Street, E.C., on March 24th, at 3 p.m., for the purpose of hearing an account of the winding-up proceedings.

A petition presented by the Bank of Liverpool, Limited, on 11th inst., is to be heard on March 10th, for the winding up of the Morecambe Electric Light and Power Company, Limited.

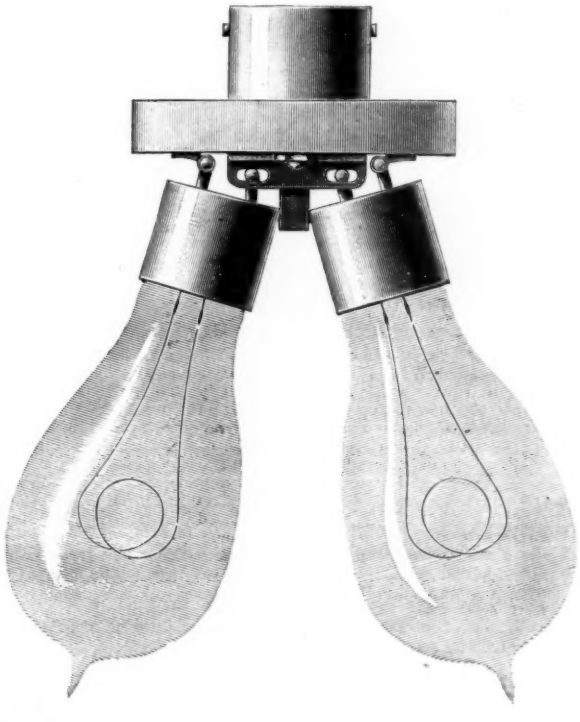
Catalogues.—A pamphlet containing illustrations and general particulars of electrically operated power pumps has been sent to us by the Knowles Steam Pump Works, of New York, whose London house is known as the Blake and Knowles Steam Pump Works, and is situated at 117, Queen Victoria Street, E.C. This catalogue has been prepared by the company from experience they have had of apparatus already built in their shops and of its actual working in consumers establishments. There are some interesting comments on general considerations in the use of electric power for such work, followed by description and tabulated details of the vertical triplex belted power pump, special belt driven electric ditto, and a number of other electric power pumps, including horizontal-triplex, horizontal-simplex, combined steam and electric. We consider this equals any other list of electric pumping machinery circulated on this side.

The catalogue which has just been issued by Messrs. Doulton & Co. of their stoneware conduits and accessories for underground electric mains, contains several new specialities. Type A casings, which are in use at Edinburgh, Sunderland, and other places are described at length, particulars being given in connection therewith of method of jointing, and methods of making house services, &c. To facilitate access to cables for the purpose of making connections for supplying consumers' premises without the insertion of service boxes, types B1 and B2 patent casings are being made. These casings are so arranged during manufacture that the top portion can be removed in two-foot lengths merely with the aid of a chisel, a special cover provided with a socket to receive the branch cables being substituted. In laying the casings the ends of the lengths are brought together on a stoneware chair, and the joint is rendered watertight with Portland cement. An article which is being largely used is the Doulton glazed stoneware pipe with patent self-fitting joints. Stoneware street boxes are an important feature among Messrs. Doulton's manufacture. The catalogue includes drawings of such boxes, which have been designed for the Sunderland Corporation electric lighting scheme. The boxes are fitted with C.I. cover plates and buried beneath the pavement, but others can be supplied suitable for fixing with covers level with the pavement. Other items in the book are ventilating boxes for electric light street boxes, Cockrill-Doulton patent tiles for building concrete walls with glazed face, insulators and culverts for bare copper mains, water-softening machinery, &c.

Messrs. Cutting Bros., of Derby, have issued a list of small continuous current dynamos and motors. Tabulated details and prices are given. A few comments are made regarding the uses of electric motors.

Greaves v. Rawson.—This action came on the other day for hearing at the Lord Mayor's Court, before the Assistant Judge and a jury. The plaintiffs, Messrs. Greaves, Pass & Co., printers and stationers, carrying on business in Coleman Street, sued the defendant, Mr. F. L. Rawson, a mechanical and electrical engineer, to recover £12 11s. 6d. for alterations effected in a prospectus of the London Redwood Company to the defendant's order. Mr. O. Cohen (instructed by Mr. Preston) was counsel for the plaintiffs, and Mr. G. Manchester Cohen (instructed by Mr. Easton) for the defendant. Mr. Davis, a clerk in the plaintiffs' employ, gave evidence as to the receipt of the order from the defendant in November last, and Mr. Henman, the plaintiff's manager, stated that proofs of the revised prospectus in question had been sent to and corrected by the defendant. When, in December, the account was sent in, the defendant, for the first time, suggested that a Mr. Jackson—who gave the original for the prospectus—was liable for the alterations effected. This was the defence now set up, the defendant stating that he gave the order for the revised prospectus for, and at the request of Mr. Jackson, of which fact the plaintiffs were aware. Mr. H. Ellis, a company secretary, was also called for the defendant. In the result, the jury found for the amount claimed.

The "Duplex" Incandescent Lamp.—Messrs. Gabriel and Angenault are at the moment introducing to the market a new incandescent lamp, as shown in the illustration. This type of lamp for higher pressure supply is claimed to enable the consumer to obtain the same durability, efficiency, and safety as at present required for low-pressure circuits. By the "Duplex" system, if one filament gives out before the other, the bulb is replaced at small cost, whereas in the lamps in general use at present, consisting of two filaments in one bulb, the life of the lamp is dependent on the equal durability of these filaments. If a premature breakage occurs in one of them, the lamp is useless, and the consumer must replace it by another of the same type. Other disadvantages which are said to be avoided by using the "Duplex" lamps are:—Joints breaking in



transit, filaments becoming locked and short-circuiting, flaming in the bulb between platinum leads, and short-circuiting in plaster of cap between leading-in wires. No plaster being required in the cap, an ample air space is allowed between and round the leading-in wires, ensuring cool working for all candle-powers, and doing away with the risk of short-circuits and cap leakage. Filaments are made specially rigid, and can be used in any position without the use of shackles or supports.

Personal.—We understand that Mr. Haydn T. Harrison, M.I.E.E., has resigned his position as manager of the Nalder and Harrison Construction Syndicate, Limited, in order to give his whole time to testing and consulting work. His address, in future, will be Albany Buildings, 47, Victoria Street, Westminster, S.W.

Provincial Installations.—Several church and other lighting installations have just been completed by Messrs. S. Dixon and Son, of Leeds. They have just fitted up Roscoe House Chapel and Headingley Wesleyan Church, and St. James's Church, Leeds. For Mr. S. Law, of Cleckheaton, they have laid down complete plant, including gas engine and a set of E.P.S. accumulators, also for the Dewsbury Workhouse they have supplied an extension of the steam plant, and have fitted an extra 200 lights in the Old Infirmary at the same town. In the switchboard and electric lighting departments, which they have recently opened, Messrs. Dixon are very busy.

Price Lists.—Messrs. Thomas Parker, Limited, of Wolverhampton, have just issued a pocket list of their standard continuous current machinery. In the matter of neatness and general get-up the book, which consists of less than 30 pages, is all that could be desired. There are some first-class illustrations of dynamos followed by detailed specifications; particulars and prices are also given of multiple contact switches and resistance coils for shunt circuits of dynamos and motors, and motor starting switches. Messrs. Parker at the present moment have in hand plant for extension of the Liverpool Overhead Railway Company's generating station. At the present moment there are now 350 hands employed at their works at Wolverhampton.

ELECTRIC LIGHTING NOTES.

Ayr.—There was a slight failure in the electric supply a few days ago.

Bath.—Regarding the deputations to the Board of Trade, the *Bristol Mercury* says that nothing pointing to an amicable settlement was the outcome. Representatives of the Local Authority and of the Electric Lighting Company met Sir Courtenay Boyle at the Board of Trade offices, but there appeared no immediate possibility of bridging over the gulf at present dividing the parties, and no agreement of any kind was arrived at, the views of the respective deputations being very widely dissimilar.

Battersea.—The Tradesmen's Club has asked the Vestry to reconsider the matter of lighting Battersea Park Road with electricity.

Bermondsey.—A Special Committee of the Vestry is to consider and report upon the advisability of applying to the Board of Trade for a provisional order for electric lighting, also as to the advisability of erecting a dust destructor in conjunction therewith.

Brighton.—The report of the Borough Surveyor as to the side streets affected by the electric lighting in Western Road, North Street, Ship Street, and St. James's Street, recommending that 20 additional lamps should be erected and eight of the existing lamps discontinued, has been adopted by the Council.

Cardiff.—The inquiry made by Mr. H. J. Hallet into the circumstances which led to the suspension of one of the assistant engineers employed at the Corporation electrical works at Cardiff by Mr. Appleby, who is in charge of the staff, has at length been concluded, and on Wednesday afternoon a special meeting of the Lighting Committee, over which Alderman Carey presided, was held in the council chamber to receive and consider the result of Mr. Hallet's investigation. This was embodied in a report which, while containing several suggested alterations in the composition of the staff of the electrical department, was most satisfactory, as it allayed all fears which had arisen from certain allegations which had been made as to the unsatisfactory condition of the plant itself. Mr. Hallet said that the condition of the boilers caused no necessity for alarm, although several alterations could be made to make the working of the machinery more efficient. There was nothing serious the matter, however, and mountains had been made out of molehills, for the complaints made against the machinery were such as were likely to be made against any machinery which had been running for some time. It was resolved that the report and suggestions of Mr. Hallet be adopted and acted upon.

Edinburgh.—Proposals came before the Cleaning and Lighting Committee the other day for lighting an additional number of thoroughfares by electricity; but the committee decided to make no recommendation regarding them.

Augustine Church has been wired and fitted for electric lighting. The halls are also to be so prepared for incandescent lighting. Messrs. Lowdon Bros., of Dundee, are responsible for the work.

Glasgow.—We hear that it is proposed to dissever the Corporation Electric Lighting Department from the Gas Lighting Department.

Reports have been submitted by Mr. Foulis, gas manager, and Mr. Arnot, the electric engineer, bearing upon the position of electric lighting matters as at present existing, and making suggestions with the view to improvement. The Electric Lighting Sub-committee agreed to co-operate with the Watching and Lighting Committee so far as street lighting is concerned. The whole system will be fully discussed by the joint committee on an early date, with a view to the adoption of the best method of lighting the entire municipality by electricity.

Glasgow.—Very satisfactory progress is being made with the municipal electric lighting at Glasgow. Since the beginning of 1895, the number of lamps in use has increased 40 per cent., 7 per cent. of this being due to electric lamps displacing those of incandescent gas. The total number of incandescent lamps now amounts to 73,400, representing an output of 2,480 kilowatts. The actual number of lamps running at one time is 50 per cent. of the total number. There are also at present 112 arc lamps being run from the sub-station, but, owing to the arrangement of the lamp-posts and lamps, they have not given entire satisfaction; this fact has been magnified into the statement that the lighting, generally, is not satisfactory, but the large increase in incandescent lamps named, and the fact that very numerous further applications are being made, is a sufficient answer to this. Two new 200-unit machines have recently been installed, making 11 in all. Two large Babcock & Willcox boilers have also been added, and a third one is in course of erection. The actual increase in load has been as follows:—1893-94, 7,000, 1894-95, 9,000, 1895-96, 12,000.

Halifax.—A sub-committee is to prepare an estimate of the cost of lighting the Town Hall by electricity. It is proposed that the Council Chamber, committee rooms, and offices shall be lighted by a number of incandescent lamps, at a cost of £400.

Huddersfield.—The Local Government Board has granted the Corporation authority to borrow £50,000, to be repaid within a period of 25 years, for electric lighting purposes.

London, E.C.—The lighting of Finsbury Circus was discussed at the Commissioners of Sewers' meeting last week, a memorial having been presented asking for more effective lighting in the Circus. The Streets Committee has the matter in hand. Finsbury Circus is lighted by gas, the lamps being rather too far apart. A few electric arc lamps would meet the case splendidly.

Kingston.—The Council has insured its electric light works with the Royal Exchange Insurance Company for £8,000, at a premium of 5s. per cent. Apparatus for charging electric launches at a cost of £150 odd is to be laid down.

King's Norton.—The Guardians have resolved to light electrically a new laundry they are to erect.

Llandudno.—The Electric Lighting Committee has recommended the Council to engage Mr. A. H. Preece to report on electric lighting, upon terms specified by him.

Mullingar.—Messrs. Willis Brothers & Co., building contractors, Mullingar, have had their extensive premises there fitted up with electric lighting plant. The shop engines drive the dynamo during the day, the current being stored in accumulators capable of supplying 20 16-C.P. lamps for 3½ hours. The installation includes nine 50-C.P. lamps, eight 25-C.P. lamps, and one 2,000-C.P. "Empress" arc lamp. The work was carried out by Messrs. Tuck and Co., Limited, of Dublin, under the supervision of Mr. D. M'Dowall Grosart.

Madeira.—The concession of the electric lighting of Funchal has been granted by the King of Portugal to an English company, who will commence the work at once, and Mr. Edwin Blakey, M.I.E.E., of Bradford, has been appointed consulting engineer. As there is no gas in the city, and petroleum is exceedingly dear, the company should have an excellent field for operations. We are informed that the Government has entered into a contract with the company for lighting the streets and principal public buildings.

Plymouth.—Opponents of the electric lighting scheme are gathering together to see how they can prevent the work being proceeded with, and they intend to call a public meeting.

Shoreditch.—The Vestry has resolved to borrow the following sums:—For dust destructor buildings, chimney shaft, &c., £20,066; ironwork for dust destructor, £2,100; dust destructor and electricity supply, £9,215; total, £31,381.

St. Helen's.—The electric light mains are now being laid in Church Street. The central station will be situate in Warrington Old Road, on the Gasworks land, and the machinery will be sufficient to supply 3,000 16-C.P. incandescent electric lamps.

Swansea.—In view of the falling through of the tramway portion of the Swansea triple scheme, Messrs. J. C. Howell & Co., of Llanelly, have made a formal offer to the Corporation to purchase the provisional powers for electric lighting gained by the corporation some considerable time back.

A local paper says that Colonel Ducat, C.E., who on January 22nd held the Board of Trade inquiry into the application of the Swansea Corporation for power to borrow £60,000 in respect of the electric lighting scheme "has reported that a loan of £20,000 only should be sanctioned. If true, this report would alone be fatal to the scheme."

Tunbridge Wells.—Mr. Henry J. Wood has entrusted to Messrs. Drake & Gorham the electric lighting of Bidborough Court, by means of a separate plant consisting of a 6-brake H.P. oil engine and a shunt-wound latest pattern dynamo and 53 "D.P." cells.

Wimbledon.—A memorial signed by about 160 ratepayers was presented to the Council the other day, opposing the electric lighting scheme. The Council, however, resolved to renew their application for a provisional order, so as to get it granted prior to the expiration of the extended license.

Worcester.—On the recommendations of a special Sub-committee, 26 arc lamps are to be erected to replace 74 gas lamps. The cost of these will be £650, or less than three times the cost of gas lighting, for which 20 times the candle-power will be obtained. The capital outlay will be about £1,850.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Denton and Electric Traction.—A deputation from the District Council of Denton, near Manchester, has visited Leeds, inspecting the working of electric cars on the Roundhay Road, and hearing all they could learn concerning the intentions of the Corporation with reference to the suggested adoption of electric traction on the city tramways generally.

Dublin Electric Tramways.—On the 21st inst. the inaugural trip over the electric lines, *via* Pembroke, Blackrock, Kingstown, and Dalkey took place. The start was made from central power station at the Shelbourne Road. The start was made at 4.20, and Blackrock was reached in 20 minutes, Kingstown in 40 minutes, and all this in the smoothest possible way imaginable. There was no difficulty whatever arising except the momentary delay caused by a few passing horses. At the end of the journey the company descended at the Queen's Hotel, Dalkey. The return trip was performed within the same time, and it is expected that the line will be opened about Easter Monday.

The Dublin Corporation has now approved by 21 votes to 17 the employment of the overhead trolley system of electric traction on the lines of the Dublin Southern District Tramways Company.

Electric Traction by Alternating Currents.—It will be remembered that the electric lighting of Rome has been for some time past achieved by means of alternating currents of electricity generated by water power at Tivoli, about 15 miles distant from the city. Prof. Mengarine has now invented and patented a method for also utilising the current thus generated for the purposes of electric traction, and cars are in constant work in the Eternal City on this system. For various reasons the operation of this scheme will be watched with considerable interest. The patents relating to the system are in the hands of Mr. Henry Edmunds, of 39, Victoria Street, London, and we hope to be favoured by that gentleman soon with further particulars.

Electric Traction in Sweden.—A proposal is under consideration at Geple, a seaport on the Gulf of Bothnia, for the construction of an electric tramway in the town.

Glasgow Tramways.—The question of using electricity as a motive power on the tramways has lately been before the Tramway Committee. There is a likelihood of the committee visiting Berlin and other Continental cities where electric tramways are at work.

Newcastle Tramways.—The poll regarding the proposed Tramways Bill for replacing horse haulage by cable, electricity, or other mechanical power, has been taken, and the result declared. The polling showed 9,656 votes against and 9,363 in favour of the bill, therefore, it stands defeated. There were 7,858 rejected papers, 1,393 being bad, and the remainder were returned blank.

TELEGRAPH AND TELEPHONE NOTES.

Cable for Japan.—On Saturday last the ss. *Sarpedon* sailed from London for Nagasaki, carrying about 600 miles of cable, manufactured for the Japanese Government by the Silvertown Telegraph Company, under the inspection of Sir Samuel Canning, assisted by Mr. T. E. Gatehouse. We understand that this cable forms part of the length required to connect Japan with the recently acquired Island of Formosa.

The Pacific Cable Conference in Australia.—In reviewing the meeting recently held in Sydney for the purpose of nominating representatives of Australasia to attend the Pacific Cable Commission in London, the *Sydney Morning Herald* makes the following statement:—"The question as to whether there should be three representatives of Australasia on the Commission was first raised by Dr. Cockburn, who strongly urged that in view of the special interests involved in that Colony, a third commissioner should be appointed to specially represent the Western Colonies. He, however, failed to find any support in these opinions, as the other delegates pointed out to him that the suggestion for an amicable arrangement with South Australia had already been made, and whatever force there might have been in his proposition before, it did not now remain. The names of Lord Jersey and Sir Edwin Dawes, as well as that of Mr. T. Playford, the Agent-General for South Australia, were mentioned as suitable representatives on the Imperial Commission, but ultimately the Agents-General of the two larger colonies of New South Wales and Victoria—respectively, Sir Saul Samuel and the Hon. D. Gillies—were decided upon. It was felt that there was no necessity whatever to go outside for representatives, and besides there was a feeling that Lord Jersey might be selected as one of Great Britain's representatives, he having been sent as her special envoy to attend the Canadian Conference at Ottawa. This resolution also indicates the request of all the Colonies that on all matters of importance dealt with by the Commissioners, the whole of the Agents-General should be consulted. It has been suggested in some quarters that specialists or experts should be selected for this undertaking, but the Commissioners will have at hand all the expert knowledge in the world, and that what are required in the Commissioners are sound business judgment and a general knowledge of the surroundings of the case, rather than mere technical knowledge. The scheme has been threshed out for years, and a vast amount of expert information is in the possession of the various Governments interested. And it only requires that this information be sifted, and a decision arrived at concerning it."

List of Recent Interruptions to the Trunk Landlines in Australia:—The lines, as our readers may know, are two in number, the Port Darwin route and the Western Australian route to Roebuck Bay:—

December 18th, 1894: Both routes interrupted for about 18 hours.

January 18th or 19th till January 25th, 1895: Both routes interrupted

July 28th till July 29th, 1895: Port Darwin route interrupted.

September, 1895: "Fault still exists in Western Australian line between Bremer and Esperance Bay. All business is much delayed."

November 12th, 1895: Western Australian route interrupted between Israelite Bay and Esperance Bay.

November 23rd, 1895: Western Australian route interrupted to the westward of Israelite Bay.

January 14th, 1896: Port Darwin route interrupted for some hours.

January 18th till January 19th, 1896: Port Darwin route interrupted.

February 18th, 1896: Western Australian route interrupted towards Roebuck Bay, and towards Adelaide. Still interrupted.

Telegraph Rates to India.—A *Times* despatch, dated Calcutta, February 23rd, says that the Bengal Chamber of Commerce have addressed the Government urging that advantage should be taken of the Budapest Telegraph Conference to secure a reduction of the telegraphic charges with Europe. They suggest a reduction from 5f. to 3f. per word. This would create new traffic among the general public, which now scarcely uses the telegraph. The chamber are impressed with the fact that the present rates and the want of adequate facilities at reasonable prices are having a repressing influence upon the development of trade. They believe that greater freedom of communication by telegraph between East and West would help to increase the volume of trade between India and England. They quote figures showing that the value of messages to and from India has decreased by nearly £30,000 in the eight years following the petty reduction made at the Berlin Conference, while the value of the trans-Indian messages with China and Australia has increased by £100,000 since 1889, when the charges were reduced by about 50 per cent. Their argument is that a great reduction alone can stimulate traffic. It is hoped that English Chambers of Commerce will give full support to the proposals of the Bengal Chamber.

The Burmese Telegraph System.—In reply to Mr. Yerburgh, in the House of Commons, on Monday, Lord G. Hamilton said he had no information of an intention on the part of the Government of India to extend their Burmese telegraph system beyond its present terminus at Kieng Tung in the directions indicated.

The Telephone Service.—In the House of Commons on Monday, in reply to Mr. Tully, Mr. Hanbury said:—If it were proved in any case that the company were not affording a satisfactory service, the Government would be prepared to consider the question of the establishment of a limited competition by the Post Office. In answer to the second portion of the question, I have to say that it is not the intention of the Government to take over the entire telephone business before the expiration of the company's license.

A question was asked by Sir J. Brunner as to whether it was the intention of the Post Office, after the transfer of the telephone trunk lines from the National Telephone Company to the department, to close these trunk lines at the hours of closing of the various post offices, and thus to deprive a large body of subscribers of the convenience hitherto enjoyed by them of making use of the telephone at all hours of the night. Mr. Hanbury, in reply, stated that, from the best information in the hands of the Post Office, it appears that, except in a few cases, the telephone trunk wires are scarcely ever used at night, and the department would not, therefore, be justified in going to the expense of providing attendance after the ordinary official hours. In the first instance, therefore, it is proposed that the hours for telephone business shall be the same as for telegraph business, but the department will give careful attention to the matter, and ascertain where the requirements of the public will justify an extension of the hours. At many of the larger offices the telegraph service is open to the public all night, and there, of course, the telephone service will also be open.

Telephone Installation.—Messrs. Charles J. Grist and Co., of Gracechurch Street, E.C., have completed a telephone installation for the Surrey Commercial Dock Company. The system, or systems intercommunicating, is far larger than the one the Dock Company formerly rented from the Government, which it displaces. The system now in operation is said to be one of the largest private installations in this country. At the docks at Rotherhithe there are 12 stations on the intercommunication system (of which this firm make a speciality), and 12 stations on the central station system. The two engine houses are also connected with each other, and the principal office and the engineer's office are connected to the City office in Fenchurch Street by two metallic circuits. Special cables have been laid under the locks. The total length of wire (silicium bronze) used is about 80 miles. The instruments have been supplied by the General Electric Company, Limited, the transmitters being of the Hunnings cone pattern.

Transmission of Cable Messages by Telephone.—We understand that as the result of the endeavours of the Liverpool Chamber of Commerce for permission for cablegrams to be transmitted by telephone after 6 p.m. to private addresses, the Secretary of the Chamber has received a letter from the Postmaster-General's Department, intimating that arrangements to this end have been made with the Anglo-American, the Commercial Cable, and the Western Union Companies, and that the National Telephone Company are prepared to co-operate.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—March 1st. The Municipal Authorities of Brünn are inviting tenders for the establishment of a central station in the town for the generation and supply of electrical energy for lighting and power purposes, including that necessary for an electric tramway. Tenders to be sent to the Burgermeisteramt der Landeshauprstadt, Brünn, Austria.

Bangor.—March 18th. The Corporation invites tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the Borough.

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

Germany.—March 18th. The municipal authorities of Herne are inviting tenders for the concession for the construction of a tramway, to be operated either by means of gas motors or electricity, between Herne and Recklinghausen, a distance of about 9 kilometres. Tenders are to be directed to Der Verwaltungsausschuss, Herne, Germany.

Holland.—March 6th. Tenders are being invited by the Dutch Minister of the Waterways at the Hague, for the supply of the telegraph poles required during 1897 by the Dutch Telegraph Department. Tenders to be addressed to the Ministero du Waterstaat, the Hague.

Keighley.—March 4th. Tenders are invited for providing telephonic communication between the various buildings forming the infectious hospital now in course of erection at Morton Banks, near Keighley, for the Keighley and Bingley Joint Hospital Board. Particulars on application to Mr. Alfred Moore, clerk of the works at the hospital.

London, S.W.—March 10th. Tenders are invited for the supply and fixing of telephones and communications with certain wards and rooms of their infirmary in Cale Street, for the guardians of Chelsea, in accordance with a specification which may be obtained, and samples of the instruments and fixings, which may be seen at their offices, 250, King's Road, Chelsea.

Metropolitan Asylums Board.—The Brook Hospital Committee has instructed Prof. Kennedy to prepare specification for fitting up a telephone system, and electric bells and fire alarms in the hospital. Advertisements inviting tenders for the work are to be issued.

Norway.—March 11th. The Norwegian State Railway authorities in Christiania are inviting tenders for the supply of 26 Morse telegraph instruments, 25 Morse keys, 24 paper rollers, 11 lightning conductors, 11 galvanometers, 3 signal bells, &c. Tenders to be sent to the Expeditions Comptoir, Eisenbahn Verwaltung, Jernbanctorvet, 8/9, Christiania.

Peru.—June 1st. The Municipal Authorities of Lima, Peru, are inviting tenders for the concession for the electric lighting of the city. Tenders are to be directed to La Legation de Perou, 8, Avenue Hoche, Paris, from whom particulars may be obtained.

Portugal.—March 11th. Tenders are being invited by the Royal Company of Portuguese Railways for the supply of a quantity of electric apparatus for alarm bells. Full particulars may be had from the Paris offices of the company, at 28, Rue de Chateaudun. Tenders are to be sent to the Ingenieur, Chef du service des magasins, Compagnie Royale des Chemins de Fer Portugais, Santa Apolonia, Lisbon.

Spain.—A central station has lately been completed and put in operation in the little town of Torrelavago, near Santander. The plant comprises two Oerlikon dynamos giving 240 amperes at 125 volts, driven by two Robey compound engines, steam being supplied by two Babcock and Wilcox boilers.

Sunderland.—March 13th. The Corporation invites tenders for engines, dynamos, boilers, &c., for the electric supply station.

CLOSED.

France.—The General Direction of the French Posts and Telegraphs in Paris, have just divided a contract for 500 tons of galvanised iron wire in equal lots among the following firms:—The Société de Commentry-Fourchambault; The Société de Gorcy; The Clouteries de Mohon (Ardennes); The Forges de Franche Comté, of Besançon, and Messrs. Marcellot & Co., of Eurville.

CITY NOTES.

House-to-House Electric Lighting Company, Limited.

Mr. Wm. Page (managing director) presided over the eighth ordinary general meeting of the shareholders of the above company, held on Thursday, February 20th, at the offices, Richmond Road, Kensington.

In moving the adoption of the report, he said: Gentlemen, the report is not a very startling one in any respect. There is nothing in it which is very exciting one way or the other. There are no very great things to report, and on the other hand there are no calamities to report. Perhaps the most satisfactory thing is the continued increase in the number of connections which have been made. As we see from paragraph 3 in the report, we have steadily gone up, and now reach the number of 44,162 connected lights of 8 candle-power each, and the revenue has gone up from £5,010 in 1890 to £15,394 in 1895. This increase does not fall off; in fact the number of lights connected last year were more than in 1894. The increase in 1895 was more than the increase in 1894, and from the number of applications we have had since the beginning of the year, we have every reason to believe that in the current year the number of connections that will be made will be even greater. The number in the first six weeks of last year was 831, and in the first six weeks of this year—that is, up to this day—is 1,420. So that although the increase last year was very good, we seem to have done a great deal better this year, and that, I think, is a very satisfactory feature. Unfortunately, there has been an increase in the expenditure—an increase in the cost. For several years we kept the expenditure practically at a level. In 1892, 1893, and 1894, although the output was greatly increased during those years, still we kept the expenditure quite steady. This year it has not been so, and there has been several reasons that we do not anticipate will occur again—at any rate not for some time, and, as far as we know, not at all—which have operated to bring this about. First, I will say we are carrying out several extensive alterations at the works. Amongst others, the raising of the chimney stack, and alterations in the positions of plant which we found to be necessary, and during the carrying out of these alterations the working department had to some extent to go to the wall. That is to say, we often had to run three units of plant when, in the ordinary way, had there been no alterations going on, two would have done the same thing, and that led to some of the extra expenditure. Another matter is that our system of having such a large number of converters distributed over the district, some of them of rather an old type, comes rather expensive. They take a great deal of current, and we are now gradually changing them; banking the converters, and supplying to some extent the low tension, and, as a result of this, we anticipate a considerable decrease in the coal bill. I may say this: During the last week or two, since we have modified our working arrangements, with the fresh plant we have had brought in already, there is considerable saving shown in the coal bill, but I need not say too much about that, as we have had only a short experience of it; however I will say for myself that I shall be very much dissatisfied if there is not a good many hundred pounds off the coal bill in the current year, although we shall doubtless supply a considerably increased quantity of current. I may say that so far as our reputation goes in the district, I believe we stand very well indeed as regards the steadiness of our light, for I have again and again heard that no other supply company in London equals it in this respect, and we go to considerable expense to avoid anything like a breakdown, and we always manage to keep running. Of course, we are, as has been mentioned, I think, more than once at these general meetings, in a district which is entirely residential and that is not conducive to very heroic things in the way of returns, but with a gradual increase going on we have every hope and faith that, even although it is entirely residential, it will, when we get our number of lights sufficiently increased, prove a profitable undertaking—a far more profitable undertaking than at present. As may be seen from another paragraph in the report, we have added considerably to the plant during the year, which enables us to look forward with confidence to the future as to the company being able to keep up with the demand, and of course, we have to continue to add every year something to the plant, and that is also foreshadowed in the report. The £18,000 that has been spent during the year has been utilised by Mr. Bowden with a great deal of wisdom, and the money has been spent to the best advantage. With these few remarks, I beg to move the adoption of the report and accounts.

Mr. Germaine seconded the motion.

The Chairman: I should have mentioned that we are sorry for the absence of our chairman. We quite expected until a couple of days ago that he would have been with us, but, unfortunately, he has been kept at home in the last three or four days with sickness, and is not able to be here to-day. I shall be glad to answer any questions.

The resolution was then put and carried.

The Chairman next moved that the remainder of the dividend on the 7 per cent. cumulative preference shares be declared and paid forthwith, and this was agreed to after it had been seconded by Mr. Frost.

Mr. Frost asked if the shares of the last issue had been taken up.

The Chairman said there were four or five days yet. He did not know exactly how the things stood, but a considerable number had been taken up—he dare say quite as many as they wanted at present.

On the motion of the Chairman, seconded by Mr. W. F. Leese, Mr. W. R. Davies and Mr. R. A. Germaine were re-elected directors.

Mr. Frost moved the re-election of Messrs. Miall, Wilkins, Randall and Co., the auditors, at a remuneration of £40 per annum, and this was carried.

Mr. Germaine proposed a hearty vote of thanks to the chairman, and this Mr. Frost seconded, and it was agreed to.

The Chairman, in reply, expressed surprise at the small gathering of shareholders, considering that the number of shareholders was now 200. He supposed, however, they were perfectly satisfied with the progress of the company.

Central London Railway Company, Limited.

The report of the directors for the half-year ending December 31st, 1895, submitted to the first half-yearly ordinary general meeting of shareholders held at the Cannon Street Hotel last Wednesday, states that it will be observed that the sum of £506,420 has been received

on account of shares, and that the amount expended up to the end of the half-year under review was £168,285 6s. 2d., leaving a balance in hand of £338,134 13s. 10d. The engineers have been engaged in negotiations with the local authorities respecting the details of the stations and other works, and the contractors (the Electric Traction Company, Limited) have proceeded, as far as possible, with the acquisition of the necessary land for the station sites, and a commencement will shortly be made with the actual construction of the railway. Under Clause 28 of the Central London Act of 1892, an arrangement has been come to with the Waterloo and City Railway Company, whereby, in consideration of a contribution by them to the cost of construction, and afterwards of maintenance, they will have access by a subway from their City Terminus to the system of public subways to be constructed by the Central London Company in connection with their central City station. This arrangement will facilitate the exchange of passengers between the two companies. The Board of Trade have given the necessary certificate relative to the payment of interest during the construction of the railway, in accordance with the Central London Act of 1894. The passing of the formal resolution sanctioning the issue of the capital authorised by the Act of 1892 does not involve any increase in the amount of the capital offered for subscription in June of last year. The directors who retire by rotation are Sir Francis Knollys and the Hon. Algernon H. Mills, both of whom are eligible, and offer themselves for re-election. One of the auditors, Mr. Pannell, also retires, and is eligible for re-election.

Kensington and Knightsbridge Electric Lighting Company, Limited.

The ninth annual ordinary general meeting of the shareholders of the above company was held at No. 1, Great George Street, Westminster, on Thursday evening, February 20th, when the chair was occupied by Mr. Granville R. Ryder.

The Chairman said: Gentlemen,—I beg now to move the first resolution, "That the report and accounts now read be adopted and entered on the minutes." With regard to the year which has just passed, I think the report and accounts afford sufficient evidence that there is plenty of vitality in the company, and that our progress is steady and continuous. That progress can be pretty well shown in a very few figures. Our main mileage has increased by 1¼ mile in the course of the year—from 18¾ miles to 20 miles. The houses and shops connected have increased by 201—908 to 1,109. The lamps have increased by 1,402—from 80,678 to 94,780. The sale of electricity has increased by 250,977 units, that is, from 977,789 to 1,228,734 units; and our net revenue has increased from £9,289 to £10,988—that is, by the sum of £1,698. Gentlemen, these figures are satisfactory figures, the more so, as the comparison between 1895 and 1894 is not so favourable to 1895, in this way, because in the first half of 1894 the price charged was 8d., and it was only in the last six months of that year that it was reduced to 6d. per unit, whereas during the whole of 1895 it was at the lower rate. We also had, during a considerable portion of last year, the works and alterations going on at Kensington after the fire; consequently the business was carried on under difficulties, and great credit is due to the management for keeping the business working so efficiently as they did with all these works going on around them. With regard to some of the items in the accounts, I would like to say a few words and give a few explanations. With regard to the capital account, the first point I would call attention to is the increase, which, I am afraid, is an annual matter in the capital account. It increased in the year by some £21,230, the greater part of which was in the 4 per cent. debenture stock—all, in fact, but £200. The larger items on which that money was expended are these:—£5,840 in the purchase of freehold and leasehold property; this is the purchase of some freehold premises close to our Kensington station, which is a very great advantage to the working of the station, and gives us the elbow room so very much required. The next large item was £7,350 for engines, dynamos, and boilers; £1,357 for meters; £4,442 for mains, and £1,121 for batteries. These figures altogether make upwards of £20,000. There is another point I would also call your attention to, and that is, you see the big sum of £11,871 carried forward to cash at bankers. That sum at our bankers is much larger than usual. Owing to the fact that the debenture stock issue took place in December, and the greater portion of that money consists of the money so subscribed. In the circular sent to the shareholders about that debenture stock, by whom it was entirely subscribed, we stated that the object was the purchase of freehold property. The purchase was carried out in January. The property is really the frontage of our works at Knightsbridge, and consists almost entirely of shops. It is to the company's interest to have a comfortable space around them, but I may say with regard to those particular premises, that the rents are sufficient to pay the interest, so that really they will stand us in nothing at all in the way of loss of income. Then the next point to which I would call attention is the first item in the revenue account—manufacturing electricity, &c., which amount is £6,068 10s. 7d., an increase of £927 on the preceding year. But that £927 has produced an increased output of 251,000 units, and that 251,000 units has realised in cash about £3,400, so that it is by no means an unsatisfactory item. All the things that I have mentioned up to the present time have been on the pleasant side, but there is sometimes disagreeable things at the bottom of the bowl. The point I call attention to has considerable relation to our future, and that is with regard to rates. A new assessment has been made; we fought the matter and got some reduction; but the general result is that as far as future years are concerned, we pay four times as much in rates as at present. Instead of paying about £500 a year, these rates will be increased to about £2,000 a year, and so we look to an increased expense next year of £1,500 in the item of rates. It is a disagreeable thing, but one we can't help, and as far as I can see, there is no public opinion in our favour at all. The next point is with regard to insurance. We have been charged to the present 5s. per cent., but that has now been increased to 10s. 6d. We have done our best to get it reduced, but up to the present have not been successful. That means an increase of £250. The amount we now pay is about £236, and it will rather more than double that, and so bring it up to about £500. These are two items of considerable expense which we have to face in the future, and for which we get no return as far as I can see. There is one other point I would like to speak on, and that is with regard to the amount put to renewal, and also to goodwill. With regard to the £1,000 written off against goodwill, we have always felt that as we become more and more flourishing, we should write down to some extent the rather more unsubstantial elements of our capital account. I think goodwill comes within that category, and we thought it best to write £1,000 off that. With regard to renewals we have put the very large sum of £4,270 2s. 11d. That, of course, is a large sum, but I think it is a very important thing that that account should be kept up. Electric science is a progressive science, and new things are constantly being started which would facilitate our work, and which it is quite necessary we should possess ourselves of; and therefore it is extremely important that we should have a large fund in hand on that account to enable us to meet anything which may arise. I am sure it is the right policy for the board to pursue, and I hope you will agree with me in that. Those are the only points which occur to me, but I shall be happy to answer any questions which may be put. There is one other point suggested to me, and that is with regard to the premiums raised by the issue of the debenture stock. We thought the best use we could put it to was to put it against the expenses of buying up the debenture stock. The premiums were put against the £2,679 0s. 6d. it cost us to buy up, and reduced that amount to £1,923 15s. 6d. I move the resolution—that the report and accounts be adopted and entered on the minutes.

Mr. G. H. Hopkinson seconded the motion.

Mr. Waters congratulated the board upon the satisfactory progress and on having so well got over the difficulties of rebuilding the central station, and also on the success of their policy in the reduction of prices of current. He would like to know, however, at what figure "goodwill" stood in the books.

The Secretary: About £1,400.

Mr. Waters said he would like further to say that he was sure the shareholders appreciated the substantial amount placed to reserve, and having regard to the changing conditions of electrical science that was a very important matter.

Mr. Neville said that the company was started about four years ago, and he would like to know how the goodwill arose in the accounts.

The Chairman explained that it was for buying up the Kensington Court Company—it was given in shares, not in cash.

Mr. Neville proceeded to ask further questions regarding the issue of the debenture stock, and said that as the capital account was increased by the sum of £2,500, by the conversion of the 4½ per cent. debentures to 4 per cent. debentures, he could not see that the operation was financially advantageous to the company. He thought they might have waited till the holders would have accepted a lower rate. Further, he could not make the figures right in the balance-sheet as to the debenture stock, and he took it that the item should be £75,055, instead of £71,080, as it now stood.

Mr. Hopkinson, in reply, said that the board were asked to reduce the debenture interest, if possible, and they availed themselves of a clause to do so. To do so it was necessary to increase the debenture stock by £2,500, but that only resulted in a change of £100 a year, so that they made a distinct gain of £150 a year. Another benefit was that in future they would be able to issue stock at even a better rate; in fact, they had done so. As to the amount at which the debenture stock stood, all the money had not come into the accounts.

The resolution was then carried.

The Chairman then moved the declaration of a dividend on the ordinary shares at the rate of 7 per cent. for the half-year, making 6 per cent. for the year, and this was agreed to.

On the motion of Mr. Hopkinson, the chairman was re-elected a director, and Mr. A. S. Bolton was also re-elected a director, on the proposition of the Chairman.

Mr. Crompton moved the re-election of Messrs. Lovelock, Whiffin and Dickinson as auditors, at a remuneration of 50 guineas.

This was agreed to.

Mr. Waters moved that the sum of £600 be paid to the directors for their services during the year, being an advance of £100 on the previous year.

Mr. Neville seconded, and it was agreed to.

The meeting then closed.

The Tramways Union Company, Limited.

Mr. E. M. Underdown, Q.C., presiding on Tuesday at Winchester House, Old Broad Street, at the 22nd annual meeting of the Tramways Union Company, Limited, stated that the board had in no wise altered their opinion as to the importance of introducing electric traction in connection with their tramway undertakings at Bremen and Madrid. It was felt that only by this means could their profits be increased, or, indeed, maintained at the present figure. In all large towns it was found that after a time the fares must be reduced to meet the requirements, he would not say of the lower classes, but of all those people who did not feel inclined to pay high charges for being carried about, and under these circumstances the thing to be done was to carry such people as often as possible so as to keep up the takings per mile. They could not do that to the full extent by

means of horse traction. By means of electric traction, however, more people could be carried in one car, and at a greater speed, and what, perhaps, was the most important consideration, they could, at different periods of the day, when the traffic pressed most heavily, convey large numbers of passengers to and from particular points in a manner which it would be impossible to do with horse traction, unless they kept a very large and disproportionate stock. But with mechanical power they could, at any particular period of the 24 hours, increase the application of that power, and thereby move a larger number of cars, and so carry an additional number of people. The progress they had made in preparing for the introduction of electric traction at Bremen and Madrid had been so far quite satisfactory. In both those places, and, indeed, in all places where a change from horse traction to electric traction was proposed, the sanction of the authorities must be obtained. In reference to Bremen, he might say that the board had insisted, as part of the bargain, that there should be a considerable extension of the period of their concession. That was a most important stipulation, because the introduction of electric traction would involve an expenditure in respect of fixed appliances, and it was necessary that they should have a sufficient time allowed them in which to recoup themselves for such an outlay. This part of the arrangement had been agreed to by the authorities, so that, to that extent, they were safe. At the same time the board felt that there were other companies and combinations in Germany at the present time which were in a very favourable position for carrying out this matter in alliance with them, or independently, and without discussing that point further, he might state that the present position of things improved the capital value of this part of their undertaking very materially, whether they retained it themselves or made other arrangements with regard to it. As to Madrid, matters were very much in the same position as they were at Bremen, although they had not yet reached quite so advanced a stage, owing to the changes which had taken place in connection with the municipality. He did not think these changes were likely to be unfavourable to the company's position in that city, especially as in Spain, as elsewhere, it appeared to be the desire of the public that electric traction should be introduced. In order to meet any expenses that might be involved by the negotiations now being carried on with the authorities at Bremen and Madrid, the board had felt it right to make an issue of 5,000 shares, on which a small sum had been paid up.

Mr. Geo. Richardson (director), who, it was stated, had recently visited the company's tramways on the Continent, remarked that as they were now being worked they had valuable undertakings at Bremen and Madrid, but the board believed the introduction of electric traction would give better results. Unless, however, they obtained in some form or another a *quid pro quo* for every pound of additional capital it would be necessary to spend on the proposed alterations nothing would be done.

The report of the company, which recommended a dividend of 5 per cent. for the year having been adopted, the proceedings terminated.

Notting Hill Electric Lighting Company, Limited.

The ordinary general meeting of this company was held on Tuesday last at the offices of the company, Notting Hill Gate.

In the absence of Mr. W. Crookes, Mr. S. Walters occupied the chair, and said: In submitting the directors' report and accounts he had to present to you a favourable account of the company's progress. They proposed to ask the shareholders to declare the full dividend at the rate of 6 per cent. upon the ordinary preference shares, a dividend of 2 per cent. for the whole year, or 4s. per share upon the ordinary shares, free of income-tax, after placing £700 to the renewal and depreciation fund, and to continue the reduction of the preliminary expenses account by setting aside £151 9s. 5d., or 3 per cent. of that amount. In dealing with the accounts, he said that at the commencement of the year they allotted 450 preference shares, which had been previously applied for at par, and more recently 123 shares at £2 premium—in all, 573 shares—of which 266 are fully paid up, and 307 had £5 per share paid at the end of the financial year. The improved position of the company, and also the greater confidence felt in electric light undertakings generally as a medium for sound investments, enabled the board to raise the price to the premium named. They had subsequently received applications for all the unissued shares at the same premium, and they will be allotted as capital was required for extensions, It is a matter for congratulation that the future of the company is regarded with such confidence that they were able to issue these shares at a premium. The premiums already realised (£246) had been applied to the reduction of the preliminary expenses account, and the further amount (£2,276) which would be realised upon the issue of the remaining shares would be applied in the same manner, and when this was effected that account will be brought within comparatively small proportions, and its liquidation will gradually proceed out of revenue. Upon the expenditure side of the account there were two items to notice: "To accumulators and connections at generating station," £1,818 15s. 3d.; and "to mains, including the cost of laying and construction," £2,489 15s. 7d. With regard to the first item, it had been explained in the report that the expanding business of the company necessitated an additional battery of accumulators, which was working up to their expectations. With regard to the item for mains, two-thirds of the outlay was for carrying their mains along Addison Road, and extensions in its immediate neighbourhood, and the balance is for small extensions all over the system which are showing satisfactory indications of profitable business to the company. It would be remembered that at one time they contemplated the erection of a second central station in the neighbourhood of Addison Road for the service of that district, but great doubts were felt whether the revenue likely to be derived from that part of the area would justify the outlay involved, and, moreover, a suitable site could not be obtained for the purpose. Under the advice of their engineer, the directors made the experiment of supplying that neighbourhood from their central station, which is more than a mile distant. The result is a complete success, the concentration of their power under one roof and management proving very economical, while the supply of current to our customers is perfectly satisfactory. Their experience, so far, showed that their doubts as to a second station proving remunerative were entirely justified, as it is clear that it would not have paid its way for years. The total amount of capital called up during the year amounted to £4,195, which is about £1,500 less than the year's capital expenditure, and it has been found neccssary to call up this £1,500 recently. There had been a very satisfactory increase in the sale of current, 182,327 units having been sold against 130,266 in 1894; this had been caused by the increased number of lamps connected, the total having risen from 15,669 in 1894 to 20,307 in 1895. The debit side showed some increase, but in most of the items the increase was small, with the exception of that for maintenance and renewal of the accumulators, while in some instances there is actually a reduction. With regard to the expenditure upon the accumulators, the board had thought it advisable to charge it entirely against revenue, rather than take it out of the depreciation and renewal fund, which had thus been left intact. He would like to call attention to the low initial cost at which their current was produced, and by initial cost he meant expenditure in wages, coal and stores. The directors propose to draw £400 for their fees for the past year against £300 for 1894, and the remaining item on the account is the balance, which stands at £3,227 14s. 10d., and is carried into the net revenue account. The "depreciation and renewal fund account" now stood at £1,300, and they had had no accident which had caused them to trench upon it. It was the policy of the board to increase this fund to such a point that the company would be in a position to bear the strain of any breakdown to which, with all their care, it was obvious they were at any moment liable, without necessarily inflicting a loss of dividend upon the shareholders. An accident to a dynamo, or the breakdown of a boiler, from which they had so far been free, would make a serious inroad into this amount, and hence the directors felt sure that a policy of prudence and foresight in the establishment of a substantial reserve fund would meet with their approval. No accident had occurred in the works during the year, and the only mischance that had happened of any kind was in the time of the great frost, when a number of the water companies' pipes burst in the roadways, and through this three of their longest culverts were flooded. Of course, they lost a good amount of current, but not one of the customers was deprived of the light, and the pressure was kept up to its proper standard. They had since put in additional drains to mitigate the effects of such an occurrence in the future. It was obvious that the business of the company was increasing at a fairly satisfactory rate considering that the neighbourhood was not one of the wealthiest in London, and that the houses in many parts are more or less scattered. There was no reason why such expansion should not continue. In his opinion its rate would depend largely upon whether the improving condition of financial affairs which had undoubtedly begun continued to make progress as he believed in the absence of war or other disasters it would do. People did not wire their houses if times were bad, but with returning prosperity and confidence and with larger resources they do not mind the necessary outlay. In addition to this, there is a fair amount of new building either in progress or projected within our area, there are a large number of houses not yet lighted, and the use of electricity is increasing for other purposes, such as cooking, &c. Another important field for their operations would, he hoped, soon be available in the northern area as soon as they get the requisite powers. The Bill which was delayed by the dissolution was now before Parliament, and would, he believed, soon be passed. Then they would proceed energetically to lay their mains in the streets they had undertaken, and what was very important, they would be able to carry a trunk line down the Holland Park Avenue (Uxbridge Road), and complete the Addison Road system from the Uxbridge Road end, thus being able to maintain their pressure by a complete circuit. Hence they had a fair prospect of increase of sales. On the other side, they must look forward to some increased expenditure. They might, therefore, look forward with confidence to a steady increase in prosperity, their position being gradually strengthened as they proceeded. The lamp earning, and by that he meant the value of current consumed by each lamp on their circuit, was still low. It was about 5s. 9d., which was slightly higher than last year, when it was 5s. 4d. It was probably lower than the other London companies, and this was partly due to the superior economy of consumers, partly to the neighbourhood being lighter than other districts of London, and also to the fact that there were no public buildings, such as clubs and theatres, and but few shops, in the area. They must exercise great caution in taking such an important step as would be involved in a reduction of price, especially when it was remembered that the lamp earning was so very low. The character of the district must be considered; they had to make many extensions which only just paid their way, and of 70 installations in 1894, 23 extensions were necessary, and last year 81 new installations required 23 extensions. They had at present a scheme of rebates which was based upon the value of current consumed by each lamp, which enables those who burn lamps for a great number of hours to obtain a slight reduction, and it was possible that in the future they may consider whether a further extension of this plan was practicable. Their customers might rely upon it that they would study their interest as far as possible, and that they recognise that it was the true policy of the company, besides giving them a light which is perfectly steady, to consider what they could do to reduce its cost, when they could do so with safety to the company's progress. There remained little more to say; but that in view of fires at other electric light stations, besides revising their insurances, they had effected an insurance on

the revenue in the event of such a disaster overtaking them. The assessments for rating have been considerably increased; but acting on the advice of Mr. J. P. Grain, they decided not to proceed with the appeal upon this occasion.

The adoption of the report was then proposed, and after the board had remarked upon the obligations of the company to Mr. Shultz, the chief engineer, and the staff generally, the accounts were adopted.

North Staffordshire Tramways Company, Limited.

Electric traction took a prominent place in the speeches of Mr. Carruthers Wain at the thirtieth ordinary general meeting of the shareholders, held on Tuesday at the Guildhall Tavern, Gresham Street, E.C. The report and accounts having been adopted, he moved: "That the directors be requested to proceed with the pending negotiations with the various local authorities for the adoption of electricity as a motive power instead of steam, and that the agreement between the British Electric Traction Pioneer Company and the company, dated January 8th, 1896, be approved, and that the directors be and hereby are requested to carry the same into effect." He said the circumstances which had arisen in regard to the North Staffordshire Tramways were these: When under the usual statutory authority the Board of Trade Inspector early last year inspected their lines with a view to a renewal of the permission to use steam-power upon them, he found that a considerable amount of renewal of lines was necessary. He also discovered that there was a strong desire on the part of the inhabitants, and on the part of the local authorities, to replace the mode of force with which their line was at present worked by some other more attractive and more modern method. The company had a limit of time given to them within which to renew the bulk of their line. The desires of the inhabitants and of the local authorities went beyond the mere use of steam, and although they naturally desired the substitution of some better mode of traction, it was left to the directors to propose a mode of traction. Amongst other things, the local authorities desired that if they gave their consent to the renewal of the steam license, or to the adoption of any other power or form of traction, they should make certain extensions of their lines. Many years ago certain extensions were proposed, and now the anxiety of the district was to have those extensions made. If those lines were to be worked by steam traction, there was no possible method of raising the capital to make them; at any rate, he would not be a party to, or be in any way responsible for, attempting to make those extensions, if they were to be worked by steam power. Consequently the question of electric traction, which had come so much to the front in England of late years, had to be considered. A company well-known on account not only of the position it occupied, but on account of the gentlemen connected with it, was willing to enter into an agreement with them whereby, without asking the shareholders to put their hands into their pockets, they would subscribe the necessary capital. They would find the amount of money necessary to relay the remainder of their line, and to equip it from end to end electrically, which meant the expenditure of a very considerable amount of money—the provision of all the necessary generating plant and the supplementary station, the erection of posts and wires in the road, the bonding of the rails, so as to ensure proper electrical continuity, and everything else inseparable from an electrically worked line. They proposed to do this at a working figure which, apart from the question of interest on the capital to be raised, and the redemption of that capital within a given time, would mean a considerable advantage to the shareholders. The company had only a small length of life to run, so far as their original lease was concerned. If they agreed to equip the line electrically, they would get an extension of that term for about 15 years over and above the present term, and the debenture debt being paid off by the automatic operation of the sinking fund during that time, they would, at the end of 22 years, be in the possession of their line, which, at the end of the present term, they would not be, because it would be subject to their mortgage debt, which, at the present time, they were taking no steps to redeem. The consequence was, that any increase of traffic over and above the extremely moderate cost of working, the amount necessary to be put aside for the interest on the debentures, and the redemption of the debenture debt, would accrue to the ordinary shareholders. What that amount was likely to be he was not going to prophesy; he was not an electrical engineer. If they considered, however, what they had been able to do with the limited means at their command, he was sure they would unhesitatingly agree to the adoption of the directors' suggestions for working the line by electricity. He was confident that, from the moment they gave their approval, the position of the ordinary shareholders would be very much improved, and their security increased.

Mr. Alderman E. J. Hammersley, in seconding the motion, said it was the desire of the local authorities to act in accord with the directors of the company. The agreement which had been provisionally entered into provided that a certain sum per car mile would be paid with electric traction in lieu of steam haulage, and a certain sum per car mile would also be paid for the purpose of redeeming their present debentures and putting aside moneys which would in the course of a number of years extinguish their debenture debt and pay off the whole of the capital which was now being proposed to be raised by the company which had been referred to. In that respect, therefore, he thought they had made a fairly good bargain, and he would ask the shareholders to give their support to the directors in doing that which the local authorities demanded. By adopting electricity they would get a more frequent service of cars, and a cleaner and more effective form of traction, and in that way they would ensure the support of the public and the co-operation of the numerous local authorities in the district.

Brunner, Mond & Co., Limited.

The shareholders held their half-yearly meeting at Liverpool, on Friday, Sir J. T. Brunner, M.P., in the chair. The directors, in their report, recommended a dividend on the preference capital of 7 per cent. per annum, and a dividend on the ordinary capital of 30 per cent. per annum, carrying forward a balance of £95,677. There was to the credit of profit and loss account on the working of the half-year ended December 31st, £162,502. This, with £89,699 brought forward from the previous half-year, made a total of £252,201. In moving the adoption of the report, the Chairman referred to the fact that the company had taken possession of the new works at Middlewich on August 1st. The company had, during the last half-year, entered into an agreement with the United Alkali Company and Messrs. Bowman, Thompson & Co. The prices of alkali were below the cost of production in most cases. They thought they should not raise the market prices so as to encourage undue competition in the future.

Telegraph Construction and Maintenance Company, Limited.

The report of the directors, to be submitted to the members at the thirty-second ordinary meeting, to be held on Tuesday, March 3rd, 1896, at one o'clock precisely, states that the accounts for the year show a net profit of £32,589 14s. 1d., after charging the interest on the debentures. To this sum must be added £53,509 18s. 5d., brought forward from last year, making a total of £86,099 12s. 6d. From this amount is deducted the interim dividend of 5 per cent, paid July 23rd, 1895, amounting to £22,410, leaving £63,689 12s. 6d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1 16s. per share, or 15 per cent., free of income tax, leaving £18,869 12s. 6d. to be carried forward to the next account. Various lengths of telegraph cables have been manufactured for different cable companies, and for foreign and Colonial Governments, including 705 knots for the Government of Japan. Repairs of the Greetseil-Valentia and Hoyer-Arendal cables have been successfully carried out for the German Government. The factories at East Greenwich and Wharf Road, and the company's steamships are in good and efficient condition. The retiring directors are Mr. James Pender and Sir Robert G. W. Herbert, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson & Jefferys), and Mr. Patrick A. Glegg (of the firm of Messrs. Welton, Jones & Co.), who retire, offer themselves for re-election.

Central London Railway.

Mr. Henry Tennant presided at the half-yearly meeting of this company, held at Cannon Street on Wednesday. After referring to the report, which is reproduced in another column, the chairman said one of the first steps they had to take was to enter into communications with the public authorities whose sanction to the plans was required before the works were proceeded with. Things of this kind took time, and although a considerable period had thus been occupied, they did not think the company had, on the whole, just ground of complaint. The County Council, the Commissioners of Sewers, and other bodies had, they believed, looked upon the undertaking with a favourable eye, as one calculated greatly to promote the public interest, and had been, on the whole, disposed to act accordingly. They had certain points at which stations were to be erected, and it was from those points that the work of tunnelling must be commenced and carried on; and here arose the important question of the acquisition of property all along the line. A good many purchases had been made, and the subject was receiving every possible attention. As regarded the Mansion House Station and subways—a work of great magnitude and intricate character—the plans had been approved by the City authorities, and the contractors would before long make a commencement at that point. He might also say that tenders had been invited by the Electric Traction Company for the construction of the tunnel for nearly the whole of the line. He believed that certain difficulties had been overcome as regarded access to Liverpool Street Station, and they were now in a position to enter into an agreement which they believed would afford a satisfactory access between that station and this company's station at that point. The Waterloo and City Railway Company, whose terminus was at the end of Queen Victoria Street, had also entered into an arrangement for the use by them of the subways at the Mansion House, which the Central London Company had to construct.

Lord Colville seconded the motion, which was carried after a short discussion, to which the Chairman replied.

The retiring directors (Sir F. Knollys and the Hon. A. H. Mills) and the retiring auditor, were afterwards re-elected.

At an extraordinary general meeting held subsequently, a resolution was passed authorising the raising of £150,000 additional ordinary capital, by the issue of 15,000 new shares.

A vote of thanks to the chairman and directors closed the meeting.

City of London Electric Lighting Company, Limited.

An ordinary meeting of this company was held last Friday at Winchester House.

Sir David Salomons, who presided, reminded them that the company had been in existence barely three years and a-half. In September, 1892, they took over the pioneer company, with its unexpended capital and a few street lamps erected in Queen Victoria

Street and other parts of the City, but no private lamps. By the end of that year, however, they had connected, and were supplying with current, 20,000 private lamps with the pioneer company's machinery. During the first two years the demand for lamps was so great, that they had considerable difficulty in meeting it; and, besides, they were placed at the disadvantage of having to learn the peculiarities of the district they supplied. This experience had now been obtained, and they were able to tell from hour to hour what was likely to be required of their plant. The first two years might properly be regarded as the construction period, and although the whole of their machinery was not yet in place, they were in a very different position last year from what they were in the two preceding years. At the present time they had under one roof the largest installation in existence, and he had every reason to believe it was of a thoroughly satisfactory character. On the 12th inst. they had 202,045 lamps connected, while the applications numbered 213,224. Of course, it was impossible to connect up as soon as one made an application, and he thought the mere fact that out of 213,224 applications only 11,000 lamps were waiting to be connected—and the number was being reduced from day to day—showed that they had an active staff. Their installation was very much larger than was required to meet the present demand: During the period under review the generation and distribution expenses showed an advantage to the company, as compared with 1894 and 1893, of 20 per cent. and 30 per cent. respectively, relatively to the output. Of course, this could not go on for ever, but he hoped they had not yet reached quite the lowest point of economy in this direction. The vexed question of the telephone tubes was gradually settling itself. Owing to the great demand for the supply of current in the City, it had been necessary to use a good many of these tubes for the drawing in of cables to supply customers, and but for their use, it would probably have been impossible to avoid opening the streets a second time. An action against the company for vibration had been settled by the purchase of the property out of which the complaint arose. Every effort was made to prevent annoyance to their neighbours, and the board hoped that nothing of the sort would occur again. Referring to the suggestion which had been made by certain shareholders respecting the payment of an interim dividend on the ordinary shares, he said that at present the directors were unable to adopt such a course. They would be quite willing to send out a circular at the end of the first half-year stating the progress made by the company, and if in future their income increased to such an extent as to justify the declaration of an interim dividend, they would gladly do so. In conclusion, he moved the adoption of the report, which was seconded by the Earl of Suffolk.

Mr. Waller asked for information as to the lighting of the smaller streets in the City, and Mr. Herring and Mr. Wancke expressed an opinion that in the absence of any hitch in the business there was no reason why an interim dividend should not be paid.

In reply, the Chairman stated that their fixed charges and other expenses absorbed nearly all the money earned during the first six months, and that their dividend was really earned in the second half of the year. The question of lighting the minor streets of the City was still under consideration. Their engineer (Mr. Bailey) was in negotiation with the City authorities on the subject, and the board was anxious to get the contract settled.

The report was then adopted, and a dividend of 10s. per share, being at the rate of 5 per cent. for the year, was declared.

The Charing Cross and Strand Electricity Supply Company, Limited.

The annual meeting of this company was held on Monday last at 2, Craig's Court, W.C.

Mr. G. H. Brougham Glasier, who presided, said that the business of the company in the past year had continued to prosper. In many items of expenditure they had been able to effect considerable savings, and the output had been most satisfactory. The actual increase in the business was equal to 25 per cent., and in this respect their business had almost doubled itself in the past two years. As they were aware, the price per unit had been considerably reduced, but no doubt this reduction had commended itself to their consumers. Their pressure was very regular—a circumstance of great importance in connection with electric lighting. Notwithstanding the severe competition they had had to contend with, not a single customer had left them to go to their competitors. The station had been maintained in a high condition of efficiency. Out of the past year's earnings they had transferred £3,000 to depreciation account, which now amounted to £5,300. This transfer had had to be made, to comply with the Board of Trade regulations, before arriving at their net revenue. With regard to the provisional order which they had applied for, for a very much larger area, it was granted by the Board of Trade, and their Bill for confirming the grant passed the House of Lords last year. Owing, however, to the dissolution of Parliament, it did not get into the House of Commons, but he believed that it would be in that House in about a fortnight. They had had to meet rather strenuous opposition in connection with it from the Metropolitan Company, but they had little doubt that they would obtain their Bill. They wanted more room in order to be able to deal properly with the amount of electric energy they had to supply, and they had obtained new premises in Commercial Road, Lambeth, occupying an area of nearly three-quarters of an acre, where they were now preparing for the formation of a large station. The site was a very eligible one; it had a river frontage, which was of great importance, because they would be able to deliver their coal and other things alongside, and, therefore, they anticipated that they would be able to effect a considerable saving in the cost of production. After paying the debenture interest and writing £700 off preliminary expenses, and £300 off law costs suspense account, they proposed a dividend for the half-year at the rate of 6 per cent. per annum, making, with the interim dividend, 5 per cent. for the year. He concluded by moving the adoption of the report and the payment of the dividend recommended.

A Shareholder seconded the motion.

The Chairman, in answer to questions, stated that they did not themselves know what the expenditure would be in connection with the new station, but it would be kept down to the lowest possible sum, having due regard to the efficiency and stability of the work. They had arranged for the new capital they would require to be advanced at 4 per cent., and they would receive the money from time to time as it was wanted, so that a large sum would not be lying idle. The term of the present debentures would expire in 1900, and they had no doubt that they would then be able to pay them off and get any money they wanted for much less than 5 per cent. The percentage of costs to revenue in 1894 was 50 per cent., but in the past year it was reduced to 45 per cent.

After further remarks, the resolution to adopt the accounts was put to the meeting and carried unanimously.

W. T. Henley's Telegraph Works Company, Limited.—The directors propose, subject to audit, to pay a dividend of 5 per cent. upon the ordinary shares of the company for the year ending December 31st, 1895, making, with the 3 per cent. interim dividend already paid, a total of 8 per cent. for the year.

Telegraph Construction and Maintenance Company, Limited.—The transfer books of this company will be closed from the 24th inst. to the 3rd prox., both days inclusive, preparatory to the payment of dividend to all shareholders on the register on the 24th inst.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, March 11th, as special settling day in Westralian Electric Lighting and Supply Company, Limited—40,000 shares, fully paid, and 29,993 shares, 10s. paid.

The City of London Electric Lighting Company, Limited.—Warrants for the dividends on the preference and ordinary shares of the company have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 23rd, 1896, were £968; week ending February 24th, 1895, £949; increase, £19; total receipts for half-year, 1896, £7,914; corresponding period, 1895, £7,988; decrease, £74.

The Liverpool Overhead Railway Company. The receipts for the week ending February 23rd, 1896, amounted to £1,059; corresponding week last year, £847; increase, £212.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 21st, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,384.

NOTES.

Obituary.—Our readers will regret to hear of the sad termination to the career of Mr. A. F. St. George, the electrical engineer and chemist, who met his death on Thursday last through the explosion of a new oxygen iron cylinder, with which he was experimenting at 15, Red Lion Square, E.C. The inquest was opened on Monday last, and adjourned until March 10th. Mr. St. George will be remembered by many of our readers in connection with the St. George Telephone Company, and as the patentee of a number of inventions such as telephonic and signalling apparatus and electric accumulators about 12 or 14 years ago.

We regret to hear of the death of Mr. T. A. Edison's father. Mr. Edison has our sincere sympathies in his bereavement.

Mr. Snell's Cable Defence Scheme.—In considering a cable defence scheme, as apart from Mr. Snell's special mechanism, which may or may not be approved, it must be remembered that if sufficient encouragement was held out the Government might be induced to take steps to look into the matter, with, if rendered feasible, a very great benefit to the cable manufacturing industry. As regards electricians, it would prove of advantage if some extra employments could be found, so that the project should be encouraged as a project apart from all question of a special design. Mr. Snell should bring the matter before the President of the Institution of Electrical Engineers and his committee of national defence.

The Jandus Arc Lamp.—Prof. Houston and Mr. Kennelly have reported in very favourable terms upon a Jandus lamp submitted to them for test. It was designed to operate on incandescent circuits of from 90 to 120 volts pressure, and two runs of 50 hours each were made to determine the rate of carbon consumption. The average rate of the positive carbon was found to be 0·057 inch per working hour, and the negative 0·015, that is in the ratio of about 4 to 1. Therefore, a positive carbon, 12 inches long and ½ inch diameter, would last 210 hours, and the negative, 6 inches long, 400 hours, assuming the carbons to be entirely consumed. The average current used was 5·60 amperes, and the power consumed at 110 volts pressure—a permanent resistance being accountable for 30 volts—represented 616 watts, or 0·826 electrical horse-power. In measuring the candle-power of the lamp, both the outer and inner globes were of clear glass, and observations were made at different angles of elevation and depression. The standard of comparison was primarily a Hefner-Alteneck amyl-acetate lamp, the secondary standard being an incandescent lamp burning at an efficiency of about ¼ candle per watt. The following are the mean results of two sets of observations at various angles, the maximum C.P. observed in any position being 1,295 standard British candles :—

Angle of elevation.				Luminous intensity (British standard candle).
	25° 30′	...	...	141
	19° 20′	...	...	145
	8° 15′	...	...	177
Depression	3° 30′	...	...	189
	15°	...	...	396
	25° 30′	...	...	1,148
	34° 30′	...	...	869
	41° 45′	...	...	920
	47° 45′	...	...	1,025
	52° 43′	...	...	1,032
	56° 43′	...	...	1,035
	60°	...	...	931

From a selected list of 50 customers in the United States, we notice that these have had installed no less than 2,700 Jandus lamps, an average of 54 per customer, and a lengthy series of testimonials show that the lamp is finding favour on the other side, where it is known as the "Manhattan." The electrician to the Metropolitan Street Railway Company, New York, reckons that he saves $10 per lamp per annum compared with the ordinary arcs previously used. The electrician to the Western Union Telegraph Company, Chicago, says :—"From our experience, so far, carbons for a Manhattan lamp for one year would cost about 80 cents, while carbons for the old style lamp for the same period, and the same work, would cost about $10." A large business establishment, called the "Six Little Tailors," claim that candle-power for candle-power, the cost is about $\frac{1}{14}$th that of the usual incandescent light, and the testimonials generally must be highly gratifying to the owners of the lamp in the States, and equally so to Messrs. Drake & Gorham, who control the patents here.

Compliment to Mr. John Fyfe.—On the 19th inst. a complimentary dinner was given to Mr. John Fyfe, of Aberdeen, the proprietor of Electric Avenue, Brixton, by the traders of Brixton Road and Electric Avenue. The electric light and other up-to-date improvements introduced by Mr. Fyfe have proved such an attraction to the shopping public, that Brixton has become, perhaps, one of the most thriving shopping centres in London. At Christmas time Electric Avenue was decorated in splendid style with evergreens, illuminated by a large number of additional incandescent lamps, this work having been very successfully carried out by Mr. Christie, the engineer in charge of the Electric Avenue lighting station. This station supplies on ordinary occasions about 120 arc lamps and a large number of incandescent lamps; for the Christmas illuminations 300 additional incandescent lamps were fitted up. The dinner to Mr. Fyfe was presided over by the Hon. Evelyn Hubbard, M.P. for Brixton, Mr. William Haydon, L.C.C., being vice-chairman. Over 100 were present at the dinner, and the fact that a large number of the subscribers were from neighbouring streets, and not tenants of Mr. Fyfe, was as complimentary to the proprietor of the Electric Avenue, as it was creditable to the liberal business principles of the Brixton traders.

Lectures.—On Saturday last Lord Rayleigh began a course of lectures at the Royal Institution, on "Light." The lecturer stated his intention to treat more especially from the point of view of the wave theory.

At the Dublin Royal College of Science, on 25th inst., Prof. Barrett commenced a series of evening lectures on "Dynamos, Electric Motors, and Electric Lighting."

At Aberdeen, on 22nd inst., Mr. Wm. Noble lectured on the "Electric Telegraph" at Trinity Congregational Church.

At the Imperial Institute, on 24th inst., Mr. C. A. Kent, Secretary of the Trinity House, lectured on the "Lights of the British Isles."

At Broad Street Presbyterian Church, Birmingham, on 24th inst., a lecture on "Electricity in the Service of Man" was delivered by Messrs. W. H. Sturge and E. W. Tangye.

At the Highbury Quadrant Literary Association meeting, on Monday last, an evening with the latest marvels in electricity was arranged by Mr. P. P. Kipping, the Traffic Superintendent of the National Telephone Company. The electrophone, phonograph, telautograph, telephones, and a variety of electric fans, coils, and other working models, were shown working.

A course of four lectures on "Recent Advances in Electro-optics" is announced for delivery by Prof. Silvanus P. Thompson at the City Guilds Technical College, Finsbury, on Thursday evenings in March. These lectures will deal with the experimental work of Hertz, Lodge, Tesla, Lenard, and Röntgen. Particulars will be found in our advertising columns.

Before the Royal Scottish Society of Arts at Edinburgh, on 24 inst., Mr. E. Monkhouse delivered a lecture on "Distribution of Electric Energy in Edinburgh."

Light Railways.—At the Imperial Institute, last week, Mr. W. J. Brewer read a paper on "Light Railways : their Construction and Working." After many years' experience of railways, he was convinced that there was nothing to compare with a properly-organised system of feeders for the main lines of railway. By the aid of electricity, it would be possible to supply both power and light, not only for the lines, but for the towns and villages on their route. The lines would be a means by which a system of telegraphs and telephones could be established at a slight expense, and they would add to the income. In his opinion, the new "auto-car," in the interests of the agricultural classes, would never do the work of a light railway, simply because no road could ever equal the surface of a rail. It was absurd to argue that these feeder lines should be of the same gauge as the main lines. The loads on the cars of the feeder lines could be so arranged as to be moved from the feeder car to the main line car with the least possible amount of trouble or waste of time. As a motive power, he took his stand by electricity. The materials comprising the car, motors, standards for carrying the electric conductors, rails, and other necessary equipment, should be manufactured on the duplicating system, so as to reduce first cost and facilitate renewal.

Accidents due to Gas.—A serious gas explosion occurred on Thursday, last week, on the premises of the Corporation of the City of London, at 18, Whitecross Street, City, at the office of the Inspector of Gas Meters. The rooms on the second and third floors were completely wrecked by the explosion.

A domestic engaged at Urie House, Stonehaven, on Thursday, last week, entered a room to light the gas, when a terrific explosion occurred, and she was blown out of the room. She was burnt about the face, and the damage to the premises is estimated at £200. Mr. Alexander Bird, the proprietor, will, doubtless, now think of introducing a non-explosive illuminant.

Electrical Engineering in France.—We are informed that the Société Industrielle des Moteurs Electriques et à Vapeur (Système Heilmann) has lately secured the sole rights in the manufacture and sale of the Muller and Tudor accumulators in France. The accumulators, which have hitherto been made by the Hagen Accumulator Company at Hagen, in Germany, will now be manufactured in the company's works in France.

The Left Bank Sector (Paris).—The left bank sector in Paris at last possesses a central station for effecting the distribution of electrical energy. This station is situated at Issy, on the quays of the Seine, outside the Paris fortifications. This station is not yet finished, but it is already in a position to supply various consumers. It effects the distribution with alternating high tension current, all the plant having been supplied by the Creusot works. The alternators used are of the Zipernowsky type, and are at present three in number, giving 400 kilowatts, 3,000 volts at 42 periods per second. These alternators are worked by compound horizontal steam engines of 700 H.P., at 125 revolutions per minute. The steam is supplied by seven multitubular boilers, each giving 2,000 kg. of steam at 12 kg. Two other horizontal steam engines drive continuous current dynamos of 70 kilowatts at 110 volts, used for excitation. The distribution board is fixed to the wall at a height of 2·5 metres from the ground, and is 19 metres in length. It contains all the apparatus required for the regulation of the exciting machines, the coupling of the alternators, and for their connection in parallel by means of a suitable charging rheostat placed a little distance off. The mains consist of armoured lead-covered concentric cables, laid directly in the earth. Two feeders with a section of 200 square millimetres of section, now feed the various parts of the system, and especially four transformer sub-stations. The secondary circuits are connected by a system of naked copper cables laid on porcelain insulators in channels under the pavements. The station has only been working since the earlier part of January, and the consumers are already very numerous.

Electric Lighting.—On Wednesday evening there was on view at 71, Cornhill, in the new premises of the Union Bank of Australia, the "Cuthbert" electroliers and system of lighting, which is claimed to be new. Altogether lamps to the equivalent of over 1,000 8-C.P. have been installed. The chief feature of the system appears to be the reflection of the light from incandescent lamps from the ceiling, the lamps being fitted in metal dishes, which are suspended by means of square bronze tubes. Mr. G. Cuthbert, architect, is the inventor of the system. It is difficult, however, to see wherein lies the novelty of the system. We know of at least several important installations where it has been in vogue for some years.

Electro-Harmonic Society.—A novelty will be introduced for the "ladies' night" this evening, a dozen members of the male voice choir of the South London Musical Club having very kindly consented to give a number of part-songs, madrigals, choruses, &c. Under the direction of their most able conductor, Mr. Charles Stevens, these gentlemen will, by their highly-finished singing, delight those who are fortunate enough to hear them. The humorous element will also have a capital exponent in Mr. Harry Jones, who is entirely new to the supporters of the society. The complete programme may be seen in our advertisement supplement.

The Northern Society of Electrical Engineers.—The adjourned discussion on Mr. Robert Hammond's paper on the "Paralleling of Alternators," read by him before the Society on the 10th inst., at Manchester, will now take place on Monday, March 9th, instead of Monday, March 2nd.

Electric Traction in the Provinces.—From the reports of the North Staffordshire Tramways Company, and the Tramways Union Company meetings in our "City Notes" columns, it will be seen that these two concerns are pushing forward their electric traction schemes.

Correction.—In Lord Kelvin's Royal Society paper on "The Generation of Longitudinal Waves in Ether," which we published last week, the large and small circles should have been in one straight line and not with the small circles beneath the larger ones.

The Edinburgh Vacancy.—Between 60 and 70 applications have been received for the office of resident electrical engineer to the Corporation to fill the vacancy caused by Mr. Monkhouse's resignation.

Photographing the Unseen.—The new photography is very exhaustively treated in the March issue of the *Photographic Review*.

Long Cable Working.—Dr. Pupin, of America, who some time ago proposed the by no means novel idea of increasing the working speed of long submarine cables by dividing them into sections and connecting them up by condenser repeaters, appears to be still working at the idea, and to be still confident he is on the right track, though it does not appear that he has made any practical experiments to prove his case. As we pointed out some time ago, the idea has been very largely threshed out by the British postal electricians, and the same proved to be a delusion. The interposition of condenser repeaters does not increase working speed; it tends to reduce it. The idea still holds amongst many that condensers are used on submarine cables to obtain increased working speed; the reason that they are a necessary coil to cut off earth currents not being understood.

The Telegraph Service.—A return relating to the Post Office Telegraph Service, issued yesterday, gives the total receipts for 1895 as £2,646,414, and the expenditure £2,788,051, thus showing a loss of £141,637.

Society of Arts.—On Wednesday, March 4th, at 8 p.m., a paper on "Röntgen's Photography of the Invisible" will be read by A. A. Campbell Swinton. Prof. James Dewar, M.A., LL.D., F.R.S., will preside.

The French Association for the Advancement of Science.—The next meeting of the French Association for the Advancement of Science is to be held in Tunis from April 1st to 4th next.

The Institution of Electrical Engineers.—By permission of Mr. S. W. Baynes, a party of students will visit the central stations of St. Pancras Vestry on Wednesday, March 4th, at 6 p.m.

Electrocution.—The New York *World* says that the Ohio Legislature is now considering a Bill providing for the substitution of electricity for hanging in that State.

The Royal Society.—Before this Society, yesterday afternoon, the Bakerian lecture on "The Diffusion of Metals" was delivered by Prof. Roberts-Austen, F.R.S.

NEW COMPANY REGISTERED.

Holophane, Limited (46,904).—This company was registered on February 19th, with a capital of £100,000 in £1 shares, to adopt a certain agreement, and to acquire, develop, turn to account, and work certain patent rights for the construction of Holophane glass globes. The subscribers (with one share each) are:—R. Dixon, Savoy Mansions, Savoy, solicitor; B. Elkin, Savoy Mansions, Savoy, solicitor; R. I. Henriques, 16, Oxford Square, gentleman; W. J. Savage, Heigham Road, E. Ham, director; R. E. Dixon, Heath Lodge, Twickenham, gentleman; A. E. Kenny, 37, Heeley Road, Shepherd's Bush, clerk; J. Spiers, 31, Sutherland Square, S.E., gentleman. The number of directors is not to be less than five nor more than 10; the subscribers are to appoint the first; qualification, £200; remuneration £100 each per annum, and £150 extra for the chairman. Registered by Dixon & Co., Savoy Mansions, Savoy, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Venezuela Telephone and Electrical Appliances Company, Limited (31,305).—This company's annual return was filed on January 14th. The capital of £70,000 in £1 shares has been taken up, and 56,506 shares are considered as paid. £13,494 has been paid on the rest.

Wimshurst, Hollick & Co., Limited (44,466).—This company's annual return was filed on January 3rd. The capital is £40,000, in £5 shares (of which 4,000 are preference). 895 preference and 4,000 ordinary have been taken up, and the ordinary have been issued as paid. The full amount has been called and paid on the preference shares.

Westralian Electric Lighting and Supply Company, Limited (45,136).—This company's statutory return was filed on January 30th. The capital is £80,000 in £1 shares, and 70,000 are now taken up. 40,000 of these are considered as paid. £1 per share has been called on 4,400, and 10s. on 25,600, and £9,350 has been paid, leaving £7,850 outstanding.

Headland's Patent Electric Storage Battery Company, Limited (45,524).—This company's statutory return was filed on February 13th. The capital is £15,000, in £1 shares, and £14,993 are considered as paid; £5 has been paid on the rest, leaving £2 outstanding.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Feb. 19th.	Closing Quotation Feb. 26th.	Business done during week ended Feb. 26th, 1896. Highest.	Lowest
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10½— 10⅝	10½— 10⅝	...	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	45 — 48 xd	45 — 48	46½	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	87 — 88	87 — 88	88	87
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	7½— 8	7½— 7⅝	7⅝	7⅝
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	14— 14½	14 — 14½	14 9/16	14
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3½ — 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½xd	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½xd	20½ — 21½	21	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	...	104 —107 %	104 —107 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	9 — 9½	9 — 9½	9⅝	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	17 — 17½	17 — 17½	17½	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18 — 18½	18 — 18½	...	...
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	106½	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	128 —131	129 —132	130⅝	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17½— 18	17⅞ — 18⅛	18⅛	17⅞
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	101½	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	127 —130	128 —131	...	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600*l*	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	105 —108 xd	105 —108	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115 %	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	...	10 — 10⅛	10 — 10½	10½	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16½— 17	16⅝— 17½	17	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	8⅝%	...	22¼— 22⅜	22¼— 22⅜	22⅝	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	46 — 49	46 — 49	48	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	107 —111	107 —111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	6⅜— 6⅝	6⅜— 7	6 13/16	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	17⅜	17⅛
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 17	16 — 17	17	16⅛
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 6⅞	6⅜— 6⅞	6⅞	...
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —107	104 —107	105½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	...	9/16— 11/16	9/16— 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	128 —133	132 —137	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3 — 3½	3½— 3⅝	3⅝	3½
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	...	93 — 98	93 — 98	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	102 —105	104¼	104
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	94 — 99	94 — 99	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	8⅝— 9¼	8⅝— 9¼	9¼	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 7	6½— 7	6⅝	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	3 — 3½	2⅞— 3¼	...	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	102 —106	102 —106	...	...
206,400*l*	Do. do. do "B," do.	100	6 %	6 %	...	102 —106	102 —106	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	½%	...	1 — 1½	1 — 1½	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10½— 11	10½— 11	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	5⅝— 6¼	6⅜— 7¼	6 3/16	6
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	6⅜— 7¼	6⅜— 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	115 — 118	115 —118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14 — 15	14½ — 15½	15	14 15/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	17	16⅛
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10½— 11	10 — 11	10½	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅞— 8⅛	7⅞— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	12 — 12½	12 — 12⅛	12⅛	12⅛
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	115 —118	115 —118	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	8½— 9	8½— 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	9½— 10 xd	9⅝— 10½	10	9 13/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½xd	9 — 9½	9½	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½— 9⅝	9½— 10	9⅝	9½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Feb. 19th.	Closing Quotation, Feb. 26th.	Business done during week ended Feb. 26th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 % §	2½%	...	1 — 1¼	1 — 1¼	1	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1½— 1⅝	1½— 1⅝	1 1/16	1½
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
830,000£	City and South London Railway	Stock	1¼%	1¼%	1 5/16 %	40 — 42	40 — 42	40⅝	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2¼ — 2⅜	2¼ — 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1⅞— 2 xd	1½ — 2	1⅝	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4 xd	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	103 —106 xd	103 —106	102½	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅝— ¾	1⅛— 1⅜	1 5/16	1 3/16
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2¼	2¼ — 2⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅝ — ⅞	⅝ — ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	¾ — 1	⅞ — 1	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	¼ — ⅜	¼ — ⅜	..	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½ — 10½	9½ — 10½	9⅝	..
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	13½ — 14½	15 — 16	15½	15¼
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	16 — 17	16½ — 17½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —112	109 —112	..	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20½— 21½	20½— 21½	21	20⅝
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2½%	13½— 13⅝xd	13⅝— 13⅞	13⅝	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16 xd	15¾—16	..	..
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	41¼	36
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	5⅜— 5⅝	5⅜— 5⅝	5⅜	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 189
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½% 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 100—105.

House-to-House Company (£5 paid), 3½—4.

Do. do. 7 % Preference, of £5, 7⅜—8¼.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅛—¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

REVIEW.

Dynamo-Electric Machinery. By Silvanus P. Thompson, D.Sc., B.A. Fifth edition. London: E. and F. N. Spon, 1896.

The fifth edition of Prof. Thompson's manual on "Dynamo-Electric Machinery" is before us, and we are pleased to see that it is a less bulky tome than the edition preceding it. Since the fourth edition appeared four years ago, much has been done in the development of the subject, chiefly in the domain of transmission of power work by alternating currents, and in the construction of the large direct current machines required for street railway power stations. In order to make room for the new matter appertaining to these branches, some remodelling of the work has been necessary. Accordingly, we find the earlier part of the book considerably compressed, much of the chapter relating to the magnetic properties of iron having been transferred to the author's book on the "Electro-magnet," and the chapter on asynchronous motors forming merely an introduction to another work of the author recently published on "Polyphase Electric Currents." In reviewing the fourth edition we suggested that the fifth edition should be divided into two handy volumes; practically, the author has now divided his work into three volumes, each, however, constituting an independent treatise.

The physical theory of the dynamo, which constitutes the first part of the work remains as before, but in the Chapter on "Actions and Reactions in the Armature," two new diagrams, figs. 54 and 66 are given, which show very clearly the rise of potential in the armature coils due to the magnetic flux, both when influenced and uninfluenced by the current in the armature. In the succeeding Chapters "Magnetic Principles," "The Magnetic Circuit," and "Forms of Field Magnets" are discussed, and all the chapters dealing with such matters as the elementary theory of the dynamo, the winding of the magnets in series, shunt and compound machines, the winding of armatures, &c., are pretty much the same as in the former edition with the exception that some forms of multipolar windings are added.

It is when we come to Chapter xiii., on the practical construction of armatures, that we find new material. Professor Thompson is apparently much in favour of the slotted or pierced armature core, and with reason so far as motor work is concerned. He points out that in the United States the smooth core is the exception rather than the rule, while in Britain the reverse is the case, and this is true. The makers here started with smooth armatures, while the makers in the States started with toothed ones. In America the great development of power plants for street railways has doubtless served to perpetuate the latter form, but here no such factor has been present to produce any modification. But apart from the fact that armatures with embedded conductors are specially fitted to meet the strains incidental to transmission work, we doubt whether other advantages should be claimed for them. Taking everything into account, the advantages and disadvantages of the two methods of construction as applied to dynamos for lighting purposes are about evenly balanced.

In Chapter xiii., various forms of slotted and pierced armatures are illustrated, and the various methods of attaching the armature core to the shaft are also shown. Not the least interesting part of the volume is that devoted to considerations respecting the relation which must exist between the magnet field and armature field of machines in order that sparkless collection may be obtained. Numerous devices to diminish the cross field are illustrated, these being in the form of auxiliary coils placed so as to neutralise the effect of the cross turns on the armature. Again, the self-compensating armature of Sayers gets its quantum of attention. It is doubtful whether any of these non-sparking devices will come into general use. Some of them have been before the electrical engineering world for ten years, the tacit verdict

respecting them apparently being that there is nothing in them. Evidently there are better ways of making good non-sparking machines than those suggested by the various designers of these devices.

To the young student of the next decade, much of the literature about non-sparking will be so much Greek. Ten years ago, when most machines sparked more or less, it was a real problem to be solved as to how sparking was caused and how it was to be avoided. Now, no machines spark to speak of, and the student of the future will learn with much bewilderment how to cure an evil he has never experienced. Who does not remember the wonderful fire-works at the collectors of the machines at the first Crystal Palace Exhibition? Now collectors and brushes give no trouble, and if the proportions which obtain in the best examples of machines published over and over again, are only adhered to, no sparking will ever be experienced.

We are sorry to notice that the author says so little about the design of multipolar dynamos, seeing that all the large generators of Continental design which are illustrated, also those for street railway power stations, are of the multi-polar type. Surely this subject should have been treated at greater length than is possible in two pages!

In presenting examples of modern dynamos (why *continuous* current rather than *direct* current, as in fourth edition) we notice much better arrangement than in previous editions. Thus, the old "A" Gramme is given side by side with Crompton's upright dynamo, which may be regarded as illustrating the modern form of the double horse-shoe magnet machine with ring armature. The other illustrations of the Gramme machines appearing in previous editions have been, we are glad to see, deleted. For comparison, one of the early upright machines of Siemens is shown side by side with a modern under-type machine. Then we have the antiquated Victoria machine once made by the Brush Company, side by side with their latest drum machine of the single-magnet under-type pattern. A galaxy of Brown Boveri, Oerlikon, and General Electric Company's multipolar machines follows, while the Edison, Edison-Hopkinson, Manchester, Johnson & Phillips, Paterson & Cooper, and Holmes machines, have all a place with others less known. These machines are typical of the best practice, and we note with satisfaction that all antiquated forms, save when comparison requires their presence, have been omitted.

In the Chapter devoted to "Arc Lighting Dynamos," figure illustrations of the familiar Brush machine, and, of course, the Thomson-Houston—the latter, this time, with its modern ring armature, instead of the now abandoned drum shown in former editions. But why cut out the Sperry and the Wood machines, both doing very good work we understand. This country has not yet produced a constant current series lighting dynamo that will work, nor is there now any likelihood of its doing so, as the tendency is to give up lighting in series, while none of the manufacturers have any money left to make experiments with.

In the Chapter devoted to "Modern Forms of Continuous Current Motors," we notice beneficial changes. The illustrations and tabulated data of the Sprague motors is new, also the illustrations of the street car motors.

The Chapter on the "Principles of Alternate Currents" has been re-written and enlarged, while the Chapter on "Alternators" has also been remodelled. Several illustrations of old alternators have been omitted, and several of recent design introduced. A great deal has been done in alternators since 1892, the date of the previous edition, and the latest machines of the great American and Continental makers have a good show. We still have the old figures quoted from Kapp's 1889 paper, read before the Civil Engineers relative to E.M.F. coefficients given; but it need scarcely be pointed out that these are quite incapable of application to the modern iron cored types of machine. All the leading alternators made in this country are described, including the Parsons turbo-generator, which has a special plate all to itself. By the way, we noticed it stated at an earlier part of the volume that the idea of pierced armature cores independently suggested itself to Parsons, Swinburne, and Brown. As regards the turbo-generator, we think the idea of the pierced core for it originated elsewhere than in Mr. Parsons busy brain, though we understand the winding in holes has been most effective in keeping the conductors *on* the armature, by no means an easy matter at 3,000 revolutions per minute. The latest alternators of the Westinghouse Company, Siemens & Halske, Brown Boveri, and the Oerlikon Company, all have a place in this new volume.

About 30 pages are devoted to alternating current motors, this chapter forming, as before stated, an introduction to the author's work dealing specially with the subject. Next follows a chapter on "Transformers," re-written with the intention of bringing this portion of the work up to date. Several recent designs are shown, but we scarcely think the transformer occupies the position in importance that it deserves. There is far too little constructive detail illustrated. The remaining portion of the work contains chapters on "Motor Generators," "Electric Transmission of Energy," "Regulators for Dynamos," "Testing Dynamos and Motors," and "The Management of Dynamos," and a good and novel feature is introduced in giving in an appendix forms of specifications for dynamos, alternators, and transformers. There are 19 plates at the end of the volume, illustrative of the best examples of modern machines. All the illustrations are good, and this book being less bulky the binding is likely to last better than that of our fourth edition. We congratulate Prof. Thompson on the most comprehensive work we have on dynamo-electric machinery having reached a fifth edition.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

(*Concluded from page* 233.)

Mr. G. L. Addenbrooke said: Before dealing directly with the question under consideration, he would say a few words on another aspect of the subject, the financial aspect of wiring. Taking the tables in *Lightning*, it would be found as a sort of rough average that central stations with mains, plant, &c., came to somewhere about £100 a kilowatt. A kilowatt capacity of plant was about 15 16-C.P. lamps, and, taking 8-C.P. lamps at 40 watts, about 25 8-C.P. lamps. They might say an average of 20 lamps, taking 8-C.P. and 16-C.P. together. Roughly, a central station provided for about double the number of lamps installed; therefore, if there was a kilowatt capacity in the station, there would be twice that in the lamps. Consequently, on that basis, they would have about 40 lamps wired for each capacity in the station. If they put these lamps down at an average of £1 apiece, *i.e.*, £40, which showed that whilst they were spending £100 on the central station, they were spending £40 in the wiring of houses. It was very easy to run through the tables in *Lightning* and find how much was spent on central stations; it, of course, amounted to some millions, and they might take a little less than half that for the cost of wiring. This still left a very large sum expended in the past, and to be expended in the future, in wiring. Therefore, this wiring question was a very important one, and demanded the greatest consideration. For instance, it was greater than any one item in the central station, except distribution; in fact, the cost of wiring was infinitely in advance of the cost of dynamos, or the cost of engines, or the cost of boilers, or any other single item. He was extremely pleased to hear what was said on the subject of earthing the middle wire. He must say it seemed to him, if it was not quite hopeless, it was very difficult to make the progress in wiring which they wanted, unless that could be done. One of the great obstacles to the extension of the electric light now—and it was an obstacle which was more felt now that the Welsbach was a competitor—was the great cost of wiring houses and the frightful mess which it involved. For this reason numbers of people went without the electric light, although the mains were at their doors, who would gladly pay any little extra cost. He thought it was almost the duty of every one of them who had anything to do with central station work, to do all they could to promote a cheaper and more efficient system of wiring. There was no doubt that one of the first requisites of a system of wiring was that they should have everything throughout to fit and correspond. Perhaps that was one of the great reasons why more progress had not been made, that and the standing and intolerable opposition of certain of the fire insurance companies. These had, of course, discouraged new work and invention almost as much as they could in many ways; still, it was no good having one thing right, the switchboard, or the fuse, or the wiring right; they had to have all right, the fittings must correspond. Therefore a great many branches of manufacture must be taken up before the thing could be dealt with, and no doubt a great many people were deterred from going into it on that account, and consequently had gone on with the old unsatisfactory double-wire casing system. Messrs. Mavor deserved very great credit indeed for the way in which they had set themselves to work to make a complete system, because there were a great many difficulties to be faced. He found that amongst his clients it was sometimes said, "You can only get your fittings from one house, and they will stick on the prices." The consequence was, that any system like this had a great deal to encounter, and those who started it met with a great deal of opposition, and had a very anxious time before it could be made to go, and they must all hope that Mr. Mavor, and those who had worked with him, would reap an advan-

tage from what they had done. It was certainly the best system, and he could say this, that having got some estimates for wiring a few months ago, the two estimates for the concentric system were under those of the double-wire system, and he was having the concentric system carried out. There was one point about the earthing of the outer wire, or the middle wire, in installations. Of course, a great deal had been said about electrolysis, and of course the most terrible effects had occurred in America, and any attempt to do as they had done with their tramways there would meet with an absolute veto on this side. But when they came to look into it, the problems were entirely different. If the middle wire was only earthed at the distribution points, and not at the feeders, and, perhaps, only earthed at the houses, they would not get much more than a fall of 3 volts, or 3 per cent., as it was now, from the feeder point to the lamps, say, 3 to 4 volts. Half that occurred on one wire, so that the fall of voltage was only one-half, 2 volts, and the amount of that which occurred in the house was of course only a fraction of that, so that any leakage there was would only be a fraction of a volt, and it should not be sufficient to set up electrolysis. As to concentric wiring for houses, he had not absolutely made up his mind whether it should be taken simply as it was, or whether it should be put in iron pipes. He saw that some wiring contractors, who did a very high-class business, were putting in a large number of pipes in their houses. They found that they could put ordinary iron pipes in at something like 4s. a light, and the wires were drawn into this; but they themselves had suggested to him that if the middle wire earthing were attempted, all they would have to do would be to take a little more care in running those pipes; use the iron pipes as the outer, and run the wires inside. It seemed to him that that would make a sound job. It would be Mavor's concentric system, so to speak, so far as the fittings, and so on, went. It would get rid of the difficulty of burying the conductors, and they could be drawn out at any time.

Mr. C. N. RUSSELL* said he had to congratulate Mr. Bathurst and Mr. Mavor upon their papers, which touched upon a subject of great interest. Mr. Bathurst's paper, which offered many points for discussion, seemed to bring forward as the problem to be solved: "How is it possible to reduce the cost of wiring to one-half what it is at present?" In order to follow the matter, he should be glad if Mr. Bathurst would let them know at what figure he had assumed the present price of wiring. Also, was it proposed that by the use of insulated tubes they could reduce the cost of wiring by 50 per cent., or even 25 per cent.? If so, it would be interesting if they could see some figures of typical installations by way of comparison. The two systems before them, although differing widely, were most excellent each in their way; and if installed properly, would do credit to any firm: at the same time it ought to be allowed that good work could be, and was, done with wood casing, which was very suitable for face work in rooms that were already decorated and free from damp. He was of opinion that wiring, by the use of wood casing, could be made to cost less than conduit work. He said could be, because wood casing lent itself to bad work by reason of its frailty. It could be cut with a pocket knife and fixed with tin tacks, and as long as the mitres of the capping were fairly made, the job, when finished, looked all right. On the other hand, if a workman was employed who was paid a fair wage, and did his work well, and who was not afraid of taking up the floor boards for his work to be inspected, he did not hesitate to say that the cost of wood casing *versus* any conduit system would be about equal, and, in a big job, would probably be in favour of the latter. Personally, he was much in favour of conduit wiring, and would welcome any system that would reduce the cost of good work; but, while he allowed the good qualities of the systems before them, he failed to see any approach to reduction of cost. He had had considerable experience in conduit wiring, with plain iron tubes coated with preservative compound, and could assure the members of that Institution that the bogies raised by Mr. Bathurst in the way of rust, condensation, &c., had caused him no trouble, although the system was extensively used. So far as his experience had been with conduit wiring, he might say that for mills, workshops and buildings in course of erection, it was well adapted, and made a first rate job, but it could not be done at a price to compete with the so-called cheap wiring at about 15s. per lamp. The difference in prime cost between wood casing and plain iron tubes, having the same duty as regards current carrying capacity, was in favour of wood casing by about 25 per cent., and in the case of insulated tubes, he took it the difference would be greater. As regarded prime cost of wiring with plain iron tube conduit, in the case of a mill having 120 16-C.P. lights, it worked out at 18s. per lamp, where each lamp had a separate switch, and the work was easy and straightforward. Those figures did not include main switchboard. He had had a few samples of joint boxes and fittings, as used by the London and Lancashire Electric and General Engineering Company, Limited, placed on the table that evening for the inspection of those interested. As far as the merits were concerned of the two systems of wiring before them, he did not think any practical man doubted their excellent qualities for a moment. But he did not see how either of them was going to assist them in reducing the cost of fitting. To do that it seemed as though they must have a new system entirely, possibly a concentric one, with the outer earthed, and with lamps and holders that could be fitted with as little trouble as a gas burner. The present form of Ediswan bayonet-joint lamp holder so much in use was, in his opinion, too complicated, and in too many pieces. The capping of the ordinary incandescent lamp was, he thought, capable of great improvement. A number of lamps of the cheap type, which he tested recently, had such a low resistance between the terminals, across the plaster setting, that in a damp atmosphere considerable leakage would have occurred. Referring again to insulated tubes, he did not quite see what was to be gained in the way of economy by dividing the insulation, and placing part on the tube, and part on the wire. Taking the comparative areas of the copper conductor and the inside of the tube, the difference was enormous, and it would seem far cheaper to pay for a first-class vulcanised insulation on the conductor, than trouble to insulate the whole of the interior area of iron tube. There was no doubt a lot of bad wiring work being done by so-called electricians, and he thought it would be well if they could have registered wiremen, like the plumbers, who were, he believed, called upon to pass a practical examination in the work they do. That, he believed, would give confidence to customers, raise the price of good work, and give them a better chance.

Prof. W. E. AYRTON* said the points to which he wished to direct their attention were rather concerning the wire than the casing, although he might say he was quite in accord with the two readers of papers in supporting a conduit system in which the wires could be drawn in and out, in preference to the old-fashioned wood casing from which the wires could not be drawn out. What, however, he wished particularly to deal with was the wire itself. Some time ago he considered these questions: Why have contractors selected particular gauges to employ? What has guided them to certain results? Why, for example, should 1,000 amperes per square inch be selected as the maximum current density? Why should they take 2 per cent. drop between the consumers' terminals and the most distant lamp in the house, when all were turned on? Was there any special reason for such numbers, or were they taken purely at haphazard? He thought contractors and electrical engineers had rather mixed up two totally distinct considerations, the question of the gauge which was safe, which did not heat by the passage of the current which it normally took, and the economic gauge to use. If they took the question of the economic gauge, they would find that the cross section was far greater than any cross section that there was any liability of heating to occur with, so that, in fact, so far as danger was concerned, they might almost dismiss the question, provided, of course, they put in such a gauge as would comply with the solution of the other problem. He was going to consider, not that he was advising a contractor who wished to put in the very cheapest work, and so get the contract, and who perhaps might be led to put in very bad material, but he would imagine that he was advising a householder, or talking to an electrical engineer who was himself advising the householder or the owners of a large building. In such a case an engineer would have to consider what gauge of wire he should use. Curiously enough the average contractor was not familiar, or did not appear to be familiar, with the actual cost of the wire. The price of the insulated wire was but a very small fraction of the sum charged and paid for putting a certain number of lamps into a house. In order to illustrate what he meant, he would take an example, an example that was as good as he could take for the other side, that is to say, it was a good example for those who allowed 2 per cent. drop between the customers' terminals and the most distant lamp, when all were turned on. He would take the case of all the lamps being on the top story, which was not really the usual thing; but they would see directly why he took that. He had worked out a case of 10 16-C P. lamps on the top story of a house, and 100 feet of wire to go up, and 100 feet to go down, assuming that there were no other lamps in the building. He would consider what wire they would have to put in such a case if they were going to have 1 per cent. drop, and if they were going to have 2 per cent. drop, how much it would each cost in such a case, and what was the difference in price. If they had the 2 per cent. drop, the actual cost of the wire, taking Class S in the Silvertown list for vulcanised wire for those 10 16-C.P. lamps, supposing the lamps took 0·6 ampere apiece, was, he found, 12s. If they took 1 per cent. drop, then the cost of this same 600-megohm wire, Class S, was 17s. The difference in cost therefore was 5s. The labour was practically the same. Now, was it worth spending that extra 5s. In this case, as all the lamps were supposed to be at the top of the house, it would be possible to use lamps intended for a lower pressure than was contained between the consumer's terminals. Suppose, for example, the declared pressure was 100 volts, they might in this particular case use 98 volts, because all the lamps were all on the one story. Supposing, on the other hand, 1 per cent. drop was employed, then they would use 99-volt lamps. The difference would be about 1 per cent. in the current. Both gave 16 C.P., and they paid roughly for 2 per cent., or for 1 per cent. more current, to produce the same amount of light. Supposing these lamps were turned on for 1,000 hours during the year, then the bill for electric energy at 6d. per unit came to £16. They paid to the supply company 320s., and 1 per cent. on that was a little more than 3s. In two years, if the thinner cable were used, the householder would have more than paid to the supply company for the difference in cost between these two wires, and ever afterwards he would be the loser, supposing he had put up a thinner wire. Now, take the real case, that was where there were lamps all over the house, and where it was quite impracticable to have lamps of different pressures on different floors. Taking an ordinary installation with a pressure of 100 volts, only 100-volt lamps would be bought, and on this top floor they would have 98 or 99 volts instead of 100, depending whether a 2 or a 1 per cent. drop was allowed. In one case the lamps would run at 99, and in the other at 98 volts. The difference of a volt at near the normal working pressure meant about 7 per cent. in the light, so that now they had to deal with, *not* 1 per cent., but 7 per cent. They had to pay extra for the same amount of light, or they got 7 per cent. less light than they had paid for. The percentage on that was 21s. Then they had this easy sum; if they put in the thicker wire for those 10 lamps at the top of the building, they would pay 5s. more to start with, initial cost, capital expenditure; but they would save 21s. a year all the time they were keeping those lamps going 1,000 hours during the year, and paying 6d. per Board of Trade unit. It was clear then—and the same result came out, whatever the number of lamps, and however distributed—that a 2 per cent. drop was an enormous extra-

* Indicates that speakers have corrected their remarks.

vagance, was an extremely bad investment for anybody who could scrape together enough money to have the thicker wire. Another interesting question arose: What was the best drop to have? He spent a good deal of time four years ago going into that problem mathematically. He need only give them the answer. The best gauge to use, the best cross-section, the most economical, assuming that they were going to pay for the installation out of their own pockets, and going also to pay the supply company for the energy afterwards, the most economical was copper as thick as they could put it in, so as not to materially increase the cost of labour. Therefore, for two mains going to any part of the building, if they had any choice between the two, if there was not sufficient difference to make the cost of labour in wiring materially different, then the thickest was the best, provided they were dealing with glow lamps, such as they now knew them, and with prices of wire and current as they now were. This result led to another very interesting one, and that was it enabled them to dispense with a great number of fuses. The old idea was, and it existed still in some specifications, to put in a fuse wherever the gauge of wire changed. Was that necessary? If they followed out the first rule, it was absolutely unnecessary. He held in his hand a flexible wire which took a current for a 16-C.P. lamp at about 450 amperes per square inch. This flexible wire was joined to a main wire, to two main wires, of course. Now, was a fuse wanted at the place where the section changed? What current would this wire stand? Nobody seemed to know. This wire, which took only 0·6 ampere at 450 amperes per square inch, had actually had 30 amperes passing through it for half an hour, and they could not see any perceptible difference in the India-rubber. The others which he held in his hands had had 35 amperes passing through them. If they use these flexible wires attached to a pair of mains which had a 10 or 15-ampere fuse, the flexible wires were absolutely safe. Therefore, if those mains supplying 10 or 15 separate lamps were all separated by pairs of flexible wires, there was absolutely no necessity to put in any separate fuses, but the room would be absolutely safe if they had outside, where the mains entered the room, a fuse which would go at, say, 10 or 15 amperes. Of course, an insurance company would tell them that was all wrong; they told him so the other day, but he found them very amenable to reason. They were very nice people when you explained things to them. It seemed to him extremely advisable that an installation should be so divided up that they could practically use everywhere the same fuse if they could, or if that was not possible, the fuses should be so constructed as to be absolutely uninterchangeable. He would not stop to give them various suggestions which occurred to him; they could all see methods of solving that problem, of avoiding the placing of a fuse in a position from which a smaller or a bigger fuse had been taken. Now, about insulation. So far he had only been dealing with the cross-section of the copper. He was an advocate of high insulated wire. He knew it would be said that the main leakage was at fuses, switches and lamp-holders, and it was no use asking for wire which would have 2,000 megohms after 24 hours' immersion in water at 60° Fah. That was not a right argument, because they could clean the switches, whereas they could not get inside the wires. Another thing—one of the reasons why so much of the leakage occurred at the switches and fuses was because, he was sorry to say, so many of them were so extremely badly designed. They would find two screws attached to the two main wires a fair distance apart, but for the fact that between them was another screw, which held the switch or the fuse to the board at the back, so that if they took from brass to brass and from brass to brass again, there was practically no surface insulation whatever. It was quite easy to arrange switches or fuses, or holders, without having them perceptibly bigger than now, and yet increase the insulation. A list was given in Mr. Bathurst's paper of the standards employed in different countries; but a high standard which was now employed by several companies in this country was left out, namely, 80 megohms per lamp. His first standard was—for 10 amperes—300,000 ohms, but there were considerably higher insulations than that already required by London supply companies. Could they get that insulation of 80 megohms in a comparatively new building? His experience was that they could, if they used good material and attended to two important points; one was always to have the tape, the outside part, removed at the ends of the wire, so that it could never come into contact with a piece of metal which was part of the live system, and another thing was to take care that the screws which passed into the porcelain, and which were used to attach wires to it, did not go right through and touch wood, or something else at the back. If they looked after those two things, and got good material, his experience was that they could get that insulation, even in buildings which had only been erected for two or three months. There was just one other point he would like to mention in passing, and that was about the iron tubes. He had some little doubt some time ago whether, in the case of two wires, the going and return conductor, drawn into an iron tube, the wires being a good deal smaller than would fill up the tube, there was not, with a 100-period alternating current, some self-induction effect that would interfere and cause a slight extra drop. Experiments, however, made in his laboratory, showed that that was not the case with the ordinary wrought-iron tube. Its permeability was so low, that even with pretty large currents passing up and back in a small iron tube, there was not much more drop in pressure than was accounted for by the resistance of the wires. With reference to the remarks of the last speaker as to the examination for wiremen, it would interest him to know that recently that had been started by the City and Guilds of London Institute—not only a written, but a practical examination to test the knowledge possessed by wiremen of jointing and things of that kind.

Dr. S. P. Thompson* said there was one paragraph in Mr. Bathurst's paper which seemed to him very important. It was the point that if they had two conductors in a pipe, and one of those conductors broke down and made contact with the uninsulated pipe, a new condition of things was set up; and it was that new condition of things that he wished to emphasise. The wire which had made contact with the pipe had now virtually got an increased carrying capacity, owing to the fact that there was a pipe parallel with it, and the other conductor, therefore, would be more liable to overheating. Further than that, the insulation having gone on one side, and practically made an earth—it might be only a local earth for the time being—there was a greater strain thrown on the insulation of the other wire. If they got anything like 200 volts into their houses, it was of the greatest importance that they should not run two bare iron wires in the bare iron pipes; that was to say, if they had a conduit system at all, there should be some kind of mechanical insulation—it need not be a high insulation—inside the pipe itself. There was a great deal to be said for a double insulation. In other conditions of electrical engineering they absolutely must have double insulation. They had high electrical insulation, even though it was but a thin skin; electrically, it was very good, but mechanically it was very poor. Another might be mechanically very good, but electrically very poor. There was that advantage in lining the pipe with an insulating material—it might be with ozokerited paper, or something of that sort—it did present mechanical contact between the wire that had broken down for the time being and the iron pipe. A double insulation, he contended, was a distinct advantage. He made an experiment in wiring some years ago. He put himself in the position spoken of by Prof. Ayrton. He did not want to save 6d., but he wanted something that was perfectly safe, and would not have an inch of wood casing anywhere. He had first of all consulted Mr. Musgrave Heaphy, who practically gave him leave to do anything he liked, provided it was not made a precedent. His reply to this was that it must be quoted as a precedent if it did well, and Mr. Heaphy did not object. He employed stranded wires highly insulated in most cases; but in one part of the house, where there was not the slightest likelihood of its having any effect, he employed a relatively lower insulation, but in every case, whether the insulation was of a really high character, or only of a moderate character, the wires were enclosed, each separately, in a lead coating, which was drawn on, and then the two lead-coated wires were put together, side by side, with a little filling in between, and braided round together, so as to form a braided twin, each of which was lead-coated, so as to keep the damp out, and with a sufficiently good insulation in the interior. It was, of course, rat-tight as well as watertight. He ran this in between the floors, without any support; it was quite strong enough to hold itself mechanically. There were no T-joints anywhere, except on the wall-faces, where they were no disfigurement. He objected altogether to fuses being put up where you could not get at them, in ceiling roses and other places; he thought they ought, in such cases, to be objected to by the Board of Trade. He would like to have every fuse placed so that it could be replaced without difficulty when the lights were on. The trouble of winding in little bits of fuse wire was very great, and one could not do it in many cases. But if fuses were made so that they could be taken out and put in again by mere replacement, it would be a very great advantage indeed. He had had no experience of concentric wires; he saw there were obvious advantages, but like the wiring in his own house, and like many other examples where wiring was put in that did not admit of replacement, there was the obvious disadvantage that they could not materially add to the number of lamps originally designed for. He had made a few experiments on the likelihood of different kinds of conduits breaking down; but they were not in such a state that he could quote them yet; but it seemed to him to be a great point that there was greater safety where a pipe, if of metal, was lined with a fairly strong and fairly good interior insulating material. Mr. Wallis-Jones thought we had got as far as the iron age; but we were told that that was to be supplanted by the aluminium age. If that were so, there would be one advantage with wood casing that by the new photography they would be able to see the joints in the wire inside.

The President said he was in a dilemma. Mr. Mavor would be unable to attend the next meeting, and unless they took his reply now, they would miss it altogether. At the same time, there were several other members who wished to speak. He would, therefore, suggest that they take Mr. Mavor's reply now, so far as they were able to get it, and then postpone the discussion till the next meeting, so far as the rest of the speakers were concerned.

Mr. Mavor said Mr. Geipel was the first speaker, and he opened his remarks by criticising the high standards of insulation set up by the fire companies. He (the speaker) thought the fire companies were wise in setting up a very high standard indeed, because of the susceptibility of double wiring and wood casing to the attacks of moisture, and to the many other ways in which faults were liable to occur. It was only by setting a very high—in fact, what seemed almost an impossibly high—standard of insulation that good work of this bad kind could be secured, and any withdrawal of this high standard would lead contractors to become more careless, and to take any departure from that standard as a license to do less careful work than they had been doing. Mr. Geipel favoured wood casing, because the work could be done by joiners; in his opinion, the whole of the work had too often been done by joiners; we have all seen samples of joiners' joints. Mr. Geipel objected to concentric wiring, because it required tradesmen to do it. He (Mr. Mavor) thought that was one of its strongest points. Mr. Geipel did not think wood casing unsightly as at present erected. That, of course, was a matter of opinion; he (the speaker) thought it was. But, Mr. Geipel said, a large number of houses were wired in London where the casing was invisible. He did not know whether Mr. Geipel had discovered an invisible paint, but if so, the sooner he advertised it the better. If the wood casing were not on the surface, and not invisible, he should doubt if it existed at all, because in a completed house, as they all knew, wood casing could not be laid under the floor without pulling it practically to pieces. If the wood

casing were there, but invisible, this was strangely at variance with Mr. Langdon's practice. Mr. Langdon believed in wood casing if you could have it on the surface, but only on the surface. Whenever he went under floors, then there must be wrought-iron tubes. These advocates of double wiring seemed to widely differ in their practice. Mr. Geipel, he thought, had misunderstood his remarks about burying conductors. In the case of wood casing, there was every reason why they should not bury them. They had many thousands of lights wired in private houses, buildings, and so on, and had never yet had to remove a conductor because of a nail being driven into it. Nowadays, when picture mouldings were put in the walls, there was even less risk. Mr. Geipel said cost alone was the vulnerable point of double wiring. He (Mr. Mavor) said it was not; the whole system bristled with vulnerable points. Every joint was a vulnerable point, every one of the double contact lampholders was a vulnerable point; in fact, the whole thing was vulnerable, unless they made it systematically damp-proof from end to end. With regard to the comparative cost of double wiring and concentric wiring, it was a very difficult question. If he asked one contractor what was the cost of double wiring, he would give one figure, whilst another would give 50 per cent. less. When they compared the cost of concentric wiring with the cost of double wiring, it should be with a first-rate job, in double wiring, and where they did that, concentric wiring was invariably cheaper. He had never seen a building yet which he could not wire more cheaply with concentric than with double wiring. The only point in Mr. Bathurst's paper he wished to criticise was one of the illustrations, which was a libel on concentric conductors. Mr. M'Lean, of Oxford, referred to the pretty things on the table, and was of opinion that he could show quite as pretty things in double wire fittings. It was rather unfortunate that Mr. M'Lean occupied a back seat, because he was quite sure if he had come down and inspected the samples, he would not have made such a rash statement. The same gentleman asked how many concentric joints there were beneath floors and behind plastered walls. Well, there were many thousands of them, and they had never had cause to get at any one of them. Mr. Langdon advocated the inspection of wiring by the supply companies. It seemed to him, however, that that was not the business of the supply companies at all, and they should have as little to do with it as possible. He did not know whether the objection to his proposal occurred to Mr. Langdon that it only provided for buildings supplied from public companies, and left out in the cold altogether thousands of isolated installations all over the country. Mr. Swinton was in error in supposing that two staffs of wiremen were necessary if a contractor wished to adopt the two methods. That was quite a mistake, as several contractors who had adopted concentric wiring had found out; there was really nothing about it that any intelligent workman could not pick up in half an hour. Not only were two staffs of men not necessary, but the staff of men required to do any particular job was very much reduced. For a job where with double wiring half-a-dozen joiners and two wiremen would be required, it would be sufficient to send two joiners and two wiremen. The amount of labour on a job was very much reduced, and as this was the most difficult kind of labour to supervise, the reduction of labour on the job was very important indeed. Then Mr. Swinton and another speaker had referred to the current carrying capacity of the wires in relation to the size of fuses. He thought the current carrying capacity of the wire had very little to do with the fuse at all. There was very little danger of the fuse being heated throughout its length by the current. The danger was from the heat being concentrated at any one point. He thought, therefore, a fuse should not be proportional to the size of the cables, but to the current they had to carry, and should have as small a margin over that current as safely might be. This was an extremely important point, and since the rules of the Institution were under revision, one rule should be added, if it had not already been considered, and that was to limit the amount of current which might be allowed in any one conductor within a building, and he submitted that something like 50 or 60 amperes should be the maximum. They might increase the number of sub-mains, but the whole point was to keep down the main fuses to as small a size as possible. Mr. Donovan impressed on them the importance of detail in double wiring. As he (the speaker) had pointed out, there was a great deal too much detail; the less there was the better. Mr. Antill thought the curve did not serve its purpose sufficiently to warrant its being shown. He thought it did. They all knew perfectly well that the number of wiremen employed at different times of the year varied considerably, and the curve did show this sufficiently approximately to warrant its being shown. It was the lamp curve for Glasgow, and the great majority of lamps wired there were in shops and offices, very few of them taking more than two or three weeks to wire, and many of them only one week. Mr. Andrews offered some words of criticism on their concentric fittings, but he did not propose to answer them until they had slain their common enemy, wood casing; they had better reserve all their combative powers for that purpose. With regard to earthing the distributing system, his opinion was, that the feeding points were the proper points to earth—insulated feeders up to the feeding point, and at every feeding point a definite earth, and of such a character that it could be removed for testing purposes if necessary. Mr. Jones spoke of the unsightliness of concentric wiring, and thought it not suited to internal house work. Mr. Jones had not seen it, and he would be very happy to show him examples of such work, which would entirely remove his impression. Mr. Swinton was under the same impression, and it had been entirely removed. [Mr. Wallis Jones: That was in Scotland.] He could now show houses similarly wired in England, and he would be very glad to give Mr. Jones, or anyone else, an opportunity of inspecting them. Mr. Addenbrooke said for ship lighting, concentric wiring was so obviously the right thing, that he was surprised it was not more generally adopted. The reason was this: wood casing was nearly always included in the shipbuilder's contract; when an owner asked for tenders for wiring, the contractor tendered for wiring only, without the wood casing. Any tender for concentric wiring was obviously seriously handicapped, for the comparison was not between wood casing and wiring, but the wiring only. With regard to Prof. Ayrton's remarks, he wondered whether Prof. Ayrton was interested in some cable company; his views with regard to the size of cables would almost indicate that he was. Prof. Ayrton, and many other speakers, seemed bent on drawing wires in and out of tubes. Why on earth should they? If they put up a job to last, why should they want to keep pulling it about? He could not understand it; he never had occasion to do so. Why they should go to all the trouble of blowing in soapstone, and so on, he did not know. He had to thank them for the kind reception of his paper, but he was rather disappointed that so much time had elapsed since the paper was read, for so many of the members seemed to have forgotten that any papers had been read, or to have forgotten what they were about.

The discussion was then adjourned until February 27th.

The Northern Society of Electrical Engineers.

The Development of Electric Lighting Engines. Paper read by H. Lindley, Member, February 24th, 1896.

In acceding to a request to write a paper on steam engines, to be read before this Society, I need hardly say my feelings were to a considerable extent tempered with hesitancy and doubt, for I could not help feeling my own unworthiness for such a task; moreover, I felt that I should have to face a keen and critical audience; for what could be more critical than one largely composed of men who, like many here to-night, have had charge of all classes of engines, and who have, no doubt, their likes and dislikes, born of long experience, and their preferences—and rightly so—for some particular kind of machine.

And here let me say that I do not intend, if I can avoid it, to express any great preference on my own behalf for any particular type of engine; but shall, I hope, deal impartially with those that now find use for electric lighting. Having mentioned the word "type," let me therefore, first of all, make an attempt to divide the various kinds of engines now in use for electric lighting purposes into some sort of divisions or classes. I do not claim any originality when I say that a very obvious method of division would be by reference to the speeds of the engines under consideration. We will, therefore, say that there are three classes, viz., slow speed, moderate speed, and high speed. There is also another motor, which we can hardly call a steam engine, though perhaps it might be difficult to say why, and which, therefore, and also on account of its enormously high speed, forms a class by itself, and which does not come within the scope of this paper.

Now, the engines to which this paper refers are what we may call ordinary engines, viz., having cylinders, pistons, &c., and the speed referred to is the speed of rotation of the crank-shaft. Another speed very frequently referred to when speaking of steam engines is that known as piston speed; it should be strictly known as mean or average piston speed, but plain piston speed is enough for our purpose, being a term familiar to you all, and well understood. Now, it is rather a singular thing that this piston speed varies but slightly in the various classes of engines we are now considering. You are just as likely to find a high piston speed in a slow speed engine as you are in a high speed one, if anything, rather more likely; there is then some connection of the inverse kind between rotation speed and piston speed, and that is, of course, the stroke; that is to say, the slow speed engine has a long stroke, the moderate speed a shorter stroke, and the high speed a still shorter stroke. Now, I do not think I need make any attempt to discover and tell you what are the advantages or objections to slow or high speed; it does not enter into the object of this paper to do so, and no doubt you are as well aware of them as I am, or better. I should, however, be very glad to hear, in any discussion there may be, the opinions of those who have engines under their charge, on the question of engine speed, all I wish to say is that *per se* slow speed has certainly obvious objections, and yet for some reason or other slow speed engines are to-day still much used for driving high speed electric lighting machinery. Now, I do not think it is difficult to find an adequate reason for this, and that is, that it is in the nature of a legacy from past ages. In the old days, before electric lighting became a burning question, suppose a man had a few machines to drive, say a saw bench or two, or some beetling or drying machines, or a few engineer's tools, and he wanted to put down an engine for the purpose, what did he do? Well, I venture to say, as a general rule, he tried hard to remember some other shop about the same size as his own, and the size of the engine that was driving it. He may possibly have had other methods, but the one above is in all probability the one that was generally adopted, and one that would give results as accurate as any other that may have been in use, including totting up the total of the horse-powers required to drive the various machines, as taken from the makers' lists.

Well, we will suppose that an engine of the size so arrived at was put in, and if it drove the shop easily, and without undue heating or excessive repairs it was accounted a good and well-made engine. On the other hand, if the engine heated badly, knocked, and wanted constant repairing, it was either a bad engine (which was probable) or too small (not so probable), and in either case it was replaced by a larger one. At about the same time or date as the above specimen of steam engineering was common among the generality of steam engine users, there was another section of them who proceeded on much more scientific lines, leaving out of the question marine or locomotive practice. I refer to the cotton industry of Lancashire, and to those who brought it to and maintained it at the high state of perfection in which it then was. The cotton spinner then, as befitted the most important steam engine proprietor and user, set to work on better lines. When he wanted to drive his mill he knew exactly how many

spindles with the necessary preparation machinery could be driven by 1 horse-power, and in buying an engine it was an easy matter of calculation to find out how much horse-power to provide. It was also an easy matter to calculate how much horse-power an engine of a given size would develop, at a given steam pressure and speed, and an engine of the size so arrived at was ordered accordingly. If then the engine did not do its work well or without breakdowns or heating, there was no question about it; it was a bad engine, and would either have to be altered or come out. But long before this the weak points of these engines had been thrashed out and eliminated, at least by engine builders of any repute, and the cotton spinner, by dealing with firms of good repute, was practically certain of getting an engine that was up to and would give the work required of it without any undue trouble. This engine, then, the Lancashire mill engine, entered the field of electric lighting almost completely prepared for the work; the only thing was, that in the early days of electric lighting it was rather too big, and there were then not many large installations requiring to be driven.

Now, as soon as it became evident that the newly opening-out field of electric lighting was likely to require the services of a large number of small-sized steam engines, nearly every maker of them suddenly awoke to the fact that his particular make of engine was particularly suited for electric lighting work, and advertised the fact.

The wish, however, was but father to the thought, and as soon as one of these engines was set to do the work that by calculation it should be equal to doing, and which also by exact calculation it was known to have to do, the crank-pin got hot. An extra large-sized lubricator was fitted to the crank-pin, and the engine was advertised as being specially designed and equipped for electric light work. But still it did not do. Why, then, did engine builders still persevere till they did produce an engine that would do the work it should do, when all the time there was the slow speed mill engine waiting and willing to do it? I have said it was too large, so it was, but it would not have been difficult to make small copies of it, and then the thing would have been done. Well, apart from other reasons that will occur to you, there was, of course, the great question of cost; the slow speed engine was too dear.

This, then, leads us to the birth of the moderate speed engine, that is the modern moderate speed one, and one that would really do without flinching the work that calculation showed it capable of doing, and keep on at it for considerable periods of time.

The thing was not so difficult after all, but it wanted doing, and, like many other things of which that may be said, it took time to do. Firstly, the stroke wanted shortening, that to a certain extent had already been done, and, secondly, the bearings wanted increasing. Here makers proceeded timidly, and it was some time before a correct proportion was arrived at. And no wonder, when we come to consider the great amount by which such bearings did require increasing. Take as an example an engine with an 8 inch cylinder, or, say, six horse-power nominal, though this term is not obsolete in connection with electric lighting work. This engine now has a crank-pin as large as that used in a 16 inch cylinder, or 25 horse-power normal of the slow speed type, not many years ago, or of to-day as made by many makers. The piston speed is about the same in both cases, but the cylinder ratios are as 1 : 4. True, the smaller cylinder has frequently to stand a rather higher pressure of steam than the older engine, but the difference is not enough to account for all that difference in the size of the crank-pins. What, then, was the cause? Why, as you will guess, the greater number of revolutions, that is the indirect cause; the more direct cause being the tendency to knock at the higher speeds, and thus displace lubricant. The main bearings have not increased in the same ratio, and for one reason, viz., that owing to the speed being higher, the fly-wheel can be much lighter and smaller.

Lubrication then also became a most important question, the extra large-sized lubricator on the crank pin, spoken of before, had to be abandoned because it could not be filled while the engine was running, and in its place some continuous method of supplying oil was adopted. A whole crowd of wick or screw adjustment oilers has, in most good engines, now been replaced by a central oil box, with a pipe to each important bearing, and having a sight drop arrangement at the box, so arranged that the supply can be cut off without altering the adjustment.

By still more perfect means of lubrication, a crank pin or main bearing can be made to run absolutely noiselessly, even though the brasses are considerably worn. It will be known to many here that Messrs. Bellis, of Birmingham, have effected this by means of forced lubrication from a pump, the oil being distributed through holes, drilled in the crank-shaft, to the various bearings. My own firm have a patent which secures the same result, at least in the case of crank pins and eccentrics, the oil in this case being led to a centrifugal oiler, and thence to a suitable cavity in the crank pin.

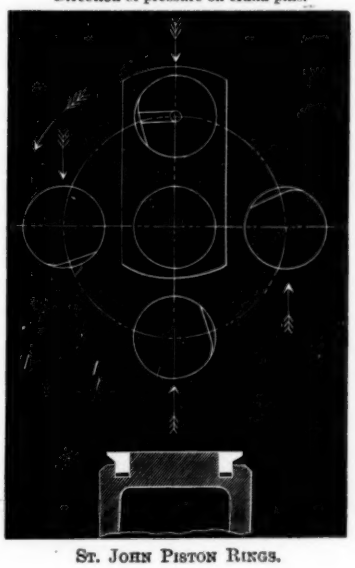
This cavity is formed by a flat, rather narrower than the width of the crank-pin, and is opened or spread out into a long oil groove, the trailing corner of which is well rounded. The position of this cavity on the crank-pin is dependent on the following fact. If you examine the forces acting on a crank-pin in a double-acting engine, you will find that there is one portion of the pin surface that is never acted on by the brasses. This is clearly shown in the drawing by arrows showing the direction of the thrust due to the steam. The cavity is formed on this portion of the crank-pin, and being kept supplied with oil, it passes over each half of the bearing in the big end of the connecting rod immediately before pressure comes on to it. The rounded shoulder facilitates the spreading of the oil, and, indeed, acts as a swab, filling up any clearance or play with oil. When pressure then comes on either brass this oil has to be expelled, and, acting as a dash pot, prevents any sudden shock or knocking, and the bearing thus runs silently.

At the same time, as affecting this displacement of lubricant by knocking, I may here mention the ingenious self-adjusting bolts of Mr. D. Abercombie, by which wear is automatically taken up as it occurs and knocking avoided. In this arrangement the nut on the ordinary marine pattern bolt, instead of being locked hard, is under the control of a torsion spring, the torsional tension on which can be varied by means of a circular ratchet at the other end of the spring. Play or strip is allowed between the two halves of the bearing, and when the brasses wear, and the nut would otherwise tend to become slack, the spring rotates the nut slightly, thus following up wear as it occurs, just as one would with finger and thumb tighten a nut on some slow moving piece when reciprocating action was causing knocking.

Another important detail that has led to the success of the modern moderate speed engine is by no means a new one; it is only the almost universal adoption of it in this class of engine that is new, and that is the use of white metal in the bearings. I believe it is not too much to say that the fast running engines of the present day, including marine and locomotive engines, in addition to those we are now considering, would be almost impossible without the use of white metal. It is impossible almost, and would at any rate be invidious to attempt to say what particular make of white metal is the best for any one purpose. There are many makes on the market, and many good ones, I believe, but to go no farther than the old Babbit metal—the advantages of its use over brass or bronze are many. Not only is it much less ready to take offence at any small particle of dirt that may get into a bearing, and get hot, but it wears longer; and moreover, by use puts a polish on the pins or journal of the shaft, that not only necessitates less oil being used, but must also reduce internal friction in the engine. In heavily loaded bearings, such as cross-head pins, &c., a quality must be used of sufficient hardness not to pound out.

Then we have another set or class of improvements that were necessary, and have been, or ought to have been, incorporated in the moderate or high speed engine of to-day. and I refer to various

Direction of pressure on crank pins.



St. John Piston Rings.

fastenings about the engine. For example, some years ago, when the firm of which I am a member first began to make engines that we fondly hoped were perfect for electric lighting work, we had the lock-nuts of one of the connecting-rod big end bolts, in a small engine, jar off whilst working. The lock-nuts were good enough for the old slower speeds, and when you could stop and tighten them if you heard the engine pounding badly through their coming loose, but they would not do for electric lighting. Nothing more serious than a stoppage (quite bad enough I admit) happened in this case, but from that date we abolished lock-nuts throughout the engine (except on main bearings), and used other and more secure devices in their stead.

Slide valves used to be secured on their spindles between lock-nuts in the old days, a doubly bad arrangement. No doubt many of you can recollect trying to tighten these at some now distant date with two keys (both too thick) and some pieces broken off the end of a file by way of packing, or with a hammer and chisel. And how the spindle used to spring when you tried to hammer against the nut on it. Apart, however, from the difficulty of tightening the lock-nuts in the valve chest of an engine, they were bad because of the small amount of surface they exposed for driving the valve. Knocking thus took place early at this part, and this tended still more to loosen the nuts. Some of you may say that a pin beyond the nuts would have prevented them coming off altogether, if it would not have prevented the knocking. So it would, but pins are very often dropped into a crank pit, or on to a dirty floor and lost, or sadder still, forgotten by an ordinary attendant; and as they do not grow anywhere about an engine room they are not always replaced, especially when, as very frequently happens, the engine is wanted to start off as soon as ready, if not sooner; and so split pins do not get us out of the difficulty, though they should still be used as an extra precaution should the

device adopted fail from any cause. Here then, again, was a point to be remedied if the engine was to do its work properly? For the same reason lock-nuts on gland studs should be abolished, and a method adopted whereby the nuts can be prevented from jarring loose, and that whilst the engine is running. The same remark also applies to the nuts on the eccentric clip bolts, though these, of course, cannot be tightened up whilst the engine is running. The crosshead and its guide, too, was in the early days unsatisfactory. In the first place unless the pin or gudgeon was too small, as it generally was, the crosshead was too heavy, the most frequent construction of forming the fork in the crosshead and fitting the brasses in an eye in the connecting rod, not allowing of a very satisfactory job being made of the crosshead if lightness were attempted, unless the pin was made rather short in the bearing. To obtain a wide pin, and at the same time a light crosshead, the plan is now almost universally adopted of forging the crosshead on the piston rod, thus saving the heavy boss, and avoiding the risk of the cotter giving out if water were met with in the cylinder, and forking the rod, by which means a wide pin and a light crosshead is obtained. It is also as well, in a crosshead of this type, to arrange it so that the pull does not come on to the cap bolts, as by this means the difficulty arising from the improperly secured nuts is avoided, and at the same time a stronger construction, weight for weight, is secured, the brasses being adjusted by means of a wedge, and the cap bolts merely being utilised to keep the cap in position, the pull due to the steam being taken by the cap itself, which is lipped over on to shoulders, formed on the crosshead for the purpose.

The slipper also, though not susceptible to any radical change, should be amply proportioned, so that there is no danger of lubricant being forced out from between it and the slide.

A word should also be said about pistons, not that there has been any very radical improvements made in them of late years, but rather that of the types to hand, the most suitable should be chosen, and, moreover, it should be carefully made.

Cast-iron rings wear very well if made of good material, but, unfortunately, they do not lend themselves, at least in the ordinary form, very well to use with a solid piston body, which is much to be preferred to one made with a junk ring, in an engine running at moderate or high speed. The ordinary pattern of piston, solid if over 16 inches or so in diameter, or made with a junk ring if less, with two cast-iron rings expanded by an inch coil answers very well for slow or very moderate speeds, but it is certainly advisable to avoid the screws necessary where a junk ring is used, and also to reduce as much as possible ring friction, which with the above construction is probably always more than necessary. The St. John steam expanded ring appears to give good results so far as I have tried it during the last two or three years, and it has the advantage that it can be made in cast-iron, and yet be sprung into a solid piston body even if of small size, and being steam expanded, it exerts a pressure on the cylinder walls in proportion only to the pressure of steam in the cylinder.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free*, 8½*d.* (*in stamps.*)]

NEW PATENTS.—1896.

2,944. "Improvements in electro-magnetic instruments." H. W. Sullivan. Dated February 10th.

2,964. "An improved system of wiring for electric installations." R. C. Quin. Dated February 10th.

3,022. "Improvements in and relating to the electrodes of secondary batteries." H. H. Lake. (H. J. Tudor, Belgium.) Dated February 10th.

3,032. "New or improved self-acting electrical signalling apparatus for preventing collisions on railways." H. O. Kraff. Dated February 10th.

3,071. "Improvements in and relating to dynamo-electric generator and motor collecting brushes." G. E. Dorman. Dated February 11th.

3,082. "Improvements in armatures for induction motors." L. Cushman. Dated February 11th.

3,083. "An improved ceiling rose and attachment therefor, chiefly applicable for electrical purposes." R. W. Braham. Dated February 11th.

3,091. "Improvements relating to the composition of the filling paste of accumulator batteries." R. Linde. Dated February 11th.

3,092. "Improvements in controllers for electric motors." J. Devonshire. (W. B. Potter, United States.) Dated February 11th.

3,093. "Improvements in controllers for dynamo-electric machines." J. Devonshire. (W. H. Knight and J. W. Darley, jun., United States.) Dated February 11th.

3,094. "Improvements in regulating phase relation of alternating currents." J. Devonshire. (E. J. Berg, United States.) Dated February 11th.

3,096. "Improvements in apparatus for regulating the tension of alternating electric currents." J. Imbay. (La Société Anonyme pour la Transmission de la Force par L'électricté, France.) Dated February 11th.

3,133. "Improvements in and relating to electric clocks." J. Wiesner and A. Witzel. Dated February 11th.

3,151. "Improvements in arc lamps." A. T. Schmidt and F. T. Schmidt. Dated February 12th.

3,213. "Improvements relating to treating or flashing filaments for electric incandescent lamps." J. H. Douglas-Willan and F. E. Bowen. Dated February 13th.

3,224. "Improvements in or connected with culverts or conduits, and insulators for carrying electric conductors, more especially intended for carrying underground bare electric conductors." W. H. Scott. Dated February 12th.

3,235. "Improvements in electric cranes." E. G. Fiegehen. Dated February 13th.

3,256. "Improvements in electric cables." G. H. Nisbett. Dated February 13th.

3,322. "Improvements in electric batteries." J. Fuchs and L. Thiemann. Dated February 13th.

3,350. "Improvements in coin-freed apparatus for administering electricity." K. Rudolph. Dated February 14th.

3,359. "Improvements in electrical furnaces for volatilising metallic and other ores." E. Bailey and J. Dunn. Dated February 14th.

3,361. "The electro-plating of iron and other metals and alloys, and the electro-reduction of metallic iron." J. Kirkwood. Dated February 14th.

3,375. "Improvements in electrical contact devices for clocks and the like." T. S. Paynter and G. C. Walker. Dated February 14th.

3,394. "Improvements in electric glow lamps." G. Webb, Jun., and L. J. Underwood. Dated February 14th.

3,409. "Improvements in or connected with recording electric meters." A. Wright. Dated February 14th.

3,441. "Improvements in or connected with or to be used with telephones." J. H. Bennet. Dated February 15th.

3,478. "Improvements in switches for controlling glow or incandescent electric lamps when used in conjunction with arc lamps." W. J. Day. Dated February 15th.

3,481. "Improvements in dynamo-electric machines," S. Z. de Ferranti. Dated February 15th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

831. "Improvements in and relating to electric arc lamps." R. C. Quin and B. Symmons. Dated January 12th. The regulating and feeding mechanism comprises a disc of conducting material mounted to rotate between the poles of a differential shunt series electro-magnet, the disc having secured to its periphery a mass of soft iron suitably counterpoised on the opposite side of the disc. The rotation of the disc by the electro-magnet causes through a suitable mechanism the striking of the arc and feeding of the carbons. 7 claims.

1,405. "Improvements in electric arc lamps." L. Barriere, Paris. Dated January 21st. Relates to a lamp in which the motion of the carbons towards each other is arrested by a band brake operated by the movable core of a solenoid wound with fine wire shunting the arc. The arc-striking solenoid is wound with thick wire in series with the arc. 11 claims.

3,582. "Improvements in casings for electricity conductors." H. Reason. Dated February 19th. Two or more tubes of lead are connected by a web of the same material provided with eyelets for nailing to the wall, &c. The tubes contain the insulated conductors. 1 claim.

3,685. "Improvements in the insulation of electric conductors." H. Edmunds. Dated February 20th. Raw wool, or wool which has not been treated for the removal of the natural fatty matter is wrapped, woven, plaited or otherwise applied to the conductor with or without the addition of other insulating material either inside or outside the wool covering. 1 claim.

3,866. "Improvements in electrical switches." R. W. H. Newington and R. Hewlett. Dated February 22nd. Relates to forming the contact faces in electrical switches of a V or pyramidal shape with corresponding recesses. 3 claims.

4,672. "Improvements in telephone and telegraph systems." H. H. Lake. (C. A. Shea and F. F. Raymond, U.S.A.) Dated March 5th. Relates to combined telephone and telegraph systems. Two telegraph lines are utilised and one telephone is arranged at each end of the lines in such a manner that the telephones will be insensible to the telegraphic currents while responsive to currents from each other. 10 claims.

20,435. "Improvements in electric brakes." J. Devonshire. Dated October 29th. The E.M.F. generated by a motor driving an electric car is utilised after the line current is cut off, in applying the brake. In the particular form described after the line circuit is broken the motors are reversed and then connected to a local circuit which applies the brake. 23 claims.

20,940. "Improvements in printing telegraphs." J. Y. Johnson. (J. E. Woodbridge, U.S.A.) Dated November 5th. Relates to printing telegraphs in which is employed a type wheel having characters arranged on its periphery and adapted to be turned to bring any desired character to the printing position. The apparatus is complicated, being described in nine pages of print, by the aid of five sheets of drawings. 16 claims.